THE UNIVERSITY OF ALBERTA

THE EFFECT OF VERBALIZERS ON THE ACHIEVEMENT OF NON-VERBALIZERS IN AN ENQUIRING CLASSROOM

by

© THOMAS [illegible]

A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE

OF MASTER OF EDUCATION

DEPARTMENT OF SECONDARY EDUCATION

EDMONTON, ALBERTA

FALL, 1970

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ABSTRACT

This study involved an investigation of the effect of student verbal participation upon achievement. Two groups of students were categorized, those who participated verbally and those who did not. Achievement was assessed on three levels representing the Knowledge and Comprehension categories of the _Taxonomy of Educational Objectives_ as the lower category and the remaining categories of the taxonomy as the higher category. The complete test comprised the composite category.

The major objectives of the study were:

1. Do non-participants benefit, as measured by an achievement test, from the verbal queries of the participants?

2. The effect of guidance upon achievement, question fluency and their quality as categorized along Suchman question analysis.

3. The possible relationship between either sociometric and/or academiometric position in a class and verbal participation.

4. Differences on the basis of reading ability and intelligence between participants and non-participants.

The data were analyzed by the technique of multiple linear regression, adjusting final achievement scores on the basis of predictors.

The following conclusions were drawn:

1. Participants gained significantly more in the higher achievement category than did non-participants.

2. Treatment had a significant bearing upon achievement in the higher and composite categories.

3. No apparent relationship was found between sociometric position and participation. Academiometric position and participation appeared to be highly dependent factors.

4. Participants had a significantly higher I.Q. and reading score than did non-participants.

The investigation highlights the need for additional studies regarding student participation and, perhaps, studies which investigate the reasons leading to student participation.

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CHAPTER I

I. PROBLEM

Introduction

During the past decade science education has been in a state of turmoil. Many new courses have been developed and different teaching procedures researched.

This study, subsumed under the investigation of enquiry, deals with classroom interaction. This could be classified under these general headings:

(a) student-teacher

(b) student-problem

(c) student-student

In this study students interacted with a problem and concomitantly caused an impact upon each other.

Statement of Problem

This study was mainly concerned with answers to the following questions which are explicitly noted in the hypotheses in this chapter.

1. Do non-participants benefit, as measured by a conventional achievement test, from the verbal queries of those who do participate?

2. What effect does guidance, provided by means of a pre-enquiry session test, have upon subsequent achievement, question fluency, and quality, as categorized along Suchman's Question Categories?

3. Is verbal participation in a classroom independent of either sociometric or academiometric position in the classroom?

4. Are there significant differences in reading achievement and non-verbal intelligence between participants and non-participants?

Definition of Terms Used

Participant or verbalizer. Participants or verbalizers are those students who pose at least one question in each of the three enquiry sessions, or those who have asked a minimum of three questions.

Non-participant or non-verbalizer. Non-participants or non-verbalizers are those students who have asked less than three questions during the three enquiry sessions.

Sociometric Star. A sociometric star is a person who has been chosen nine or more times by the rest of the members in the class as being one of five students with whom they would most like to associate. The criteria used in this selection is given by Gronlund, N.E., (1959).

Sociometric Isolate. The term sociometric isolate as used in this study, includes Gronlund's (1959) "isolate" and "neglectee" categories. A sociometric isolate in this study, is a pupil who has either not received any mention at all, or has been chosen only once, as being a person with whom the others would most like to associate.

Academic Star. An academic star is a pupil who has been chosen by at least nine other pupiles in the class, as one of the five pupils within the class who understand science best. (Gronlund, N.E., 1959).

Academic Isolate. As with the sociometric isolate, the academic isolate includes Gronlund's (1959) "isolate" and "neglectee" categories, and is a person who has received either no choices, or at most, one choice, as being a member of the class who understands science best.

Achievement Score. An achievement score is the score obtained on the test constructed by the experimenter. Three scores of ten marks each were combined in order to obtain the total score.

Lower Category Achievement. This consists of test items, as judged by a committee, to be part of Knowledge and Comprehension Categories of Bloom's Taxonomy.

Higher Category Achievement. This consists of test items, as judged by a committee to be part of Application, Analysis, Synthesis and Evaluation Categories of Bloom's Taxonomy.

Enquiry Lesson. An enquiry lesson is one conducted by the experimenter in the manner established by Suchman as described in "Problem Background".

Intelligence Score. Intelligence Score is that score obtained on a Lorge-Thorndike Non-Verbal Test, Level 4, Form A.

Reading Achievement. The reading achievement is the score obtained on the Gates Reading Survey Form 3.

II. HYPOTHESES

1.0 There will be no significant difference in the scores obtained from a non-verbal intelligence test by participant and non-participant boys and girls, and no interaction effect.

1.1 There will be no significant difference on the scores obtained from a reading comprehension test by participant and non-participant boys and girls, and no interaction effect.

2.0 There will be no significant difference in the scores obtained from a non-verbal intelligence test by participant and non-participant sociometric stars and isolates.

2.1 There will be no significant difference in the scores obtained from a reading comprehension test by participant and non-participant sociometric stars and isolates.

2.2 There will be no significant difference in the scores obtained in composite, higher or lower achievement categories by participant and non-participant sociometric stars and isolates.

3.0 There will be no significant difference in the scores obtained from a non-verbal intelligence test by participant and non-participant academiometric stars and isolates.

3.1 There will be no significant difference in the scores obtained from a reading comprehension test by participant and non-participant academiometric stars and isolates.

3.2 There will be no significant difference in the scores obtained in composite, higher or lower achievement categories by participant and non-participant academiometric stars and isolates.

4.0 There will be no significant difference in the scores obtained in composite, higher or lower achievement categories by participants and non-participants when I.Q. is used as a predictor variable, and no interaction effect.

4.1 There will be no significant difference in the scores obtained in composite, higher or lower achievement categories by participants and non-participants when I.Q. and sex are used as predictor variables, and no interaction effect.

4.2 There will be no significant difference in the scores obtained in composite, higher or lower achievement categories by participants and non-participants when reading is used as a predictor variable, and no interaction effect.

4.3 There will be no significant difference in the scores obtained in composite, higher or lower achievement categories by participants and non-participants when reading and sex are used as predictor variables, and no interaction effect.

5.0 There will be no significant difference in the scores obtained in composite, higher and lower achievement categories by participants and non-participants of treatment A when the pre-test is used as a predictor variable, and no interaction effect.

5.1 There will be no significant difference in the scores obtained in composite, higher and lower achievement categories by participants and non-participants of treatment A when pre-test and I.Q. are used as predictor variables, and no interaction effect.

5.2 There will be no significant difference in the scores obtained in composite, higher and lower achievement categories by participants and non-participants of treatment A when pre-test and reading are used as predictor variables, and no interaction effect.

6.0 Sociometric position and verbal participation in the classroom are independent factors.

6.1 Academiometric position and verbal participation in the classroom are independent factors.

7.0 Sex and verbal participation in the classroom are independent factors.

8.0 Along Suchman Categories there is no significant difference in the distribution of written questions in treatment C, as the students subsequently classify themselves in the enquiry session.

8.1 Along Suchman Categories there is no significant difference in the distribution of questions asked during the enquiry sessions between any of the treatment groups.

III. SIGNIFICANCE OF STUDY

This study appears to be justified on the basis of the following:

1. Much is found in the literature about the desirability for students to learn science by enquiry, to hold discussions, and to interact with each other. This presupposes that the students benefit from such a mode. It is one aim of this study to test the supposition that a gain in achievement can occur from within the group in an enquiry classroom.

2. Few studies in enquiry training have been concerned with anything except retention and transfer. The theory of enquiry, however, emphasizes the process of learning. This study hopes to measure conventional achievement outcomes from this process.

3. A lack of knowledge appears to exist as to how effectively children learn from one another. When only some of the students ask questions one is led to wonder whether or not the remainder benefit from this. Many studies have been done on lecture-discussion methods (carried on by the teacher), whereas this study deals with the variables within the discussion phase itself, and is carried on by the students in the classroom. This is a very crucial point, especially at a time when so many voices are raised for the desirability of enquiry learning.

4. The main question posed in this study is the effect of verbalization on the non-verbalizers. For convenience it is proposed to conduct this study at the Grade VIII level, but its applicability is by no means restricted to this grade. An answer to the question posed could conceivably guide teachers to encourage students to ask more questions or to suppress them - depending upon the findings. As such it is felt that this study has significance in helping to guide the teaching-learning process.

5. It is hoped that this study will shed some light as to the I.Q., sociometric and academiometric rating of the verbalizers and the comparison of their achievement with that of the non-verbalizers. With a knowledge of the group dynamics of a class it is hoped that

this study will help to guide a teacher as to what type of student could be asked a question so as to be most beneficial to the class.

6. Further information must be collected as to whether enquiry learning is feasible in an ongoing school situation. It must be determined whether verbal probes by some students are taken as cues by others who can then pursue the problem in some depth.

7. More must be known about the varying degrees of information, utilization and benefits arising from this before enquiry can be instituted into classrooms.

8. Data are required relating to the effect of guidance upon enquiry. If enquiry is to be instituted into the classroom, then more must be known regarding the effect of guidance. This study, by means of a pre-enquiry test in Group A, introduces an element of guidance and may thus hopefully provide some evidence as to the aspect of guidance for enquiry.

IV. LIMITATIONS

As with most investigations of this nature, rather severe limitations are necessary in order to obtain meaningful results. This study was not concerned with outlining a method for enquiry teaching. It was premised on the belief that information could be acquired about parts of the enquiry process and must, in fact, be acquired before pedagogical implications of value can be extracted. It can be recognized that the method outlined here is not an ideal teaching mode, nor is its adoption recommended. The mode, however, was utilized in this study, so as to investigate limited aspects of classroom operation

under controlled conditions.

Even though normal classroom conditions were approximated, the study did involve a laboratory type of delimitation. Hypotheses were tested and conclusions formed on the basis of groups created and instructed in the manner designed for the study.

Some other limitations are:

(a) No attempt was made to control or measure student aspiration or motivation.

(b) No attempt was made to obtain student personality profiles, nor what bearing these may have upon verbal participation.

(c) No attempt was made to determine "classroom atmosphere". It was felt that this had to be accepted as it existed.

CHAPTER II

I. REVIEW OF RELATED LITERATURE

Introduction

The new courses emphasize teaching science not as fact or content but as enquiry. A prominent theorist in this field has been Joseph Schwab.

It should be noted that the phrase "teaching of science as enquiry" is ambiguous and must be dissected into components, namely, science teaching conducted in an enquiry mode, and science being exhibited as an enquiry. In this manner science teaching can become an "enquiry into enquiry" (Schwab, 1964, p. 65). In this type of classroom one wishes not only to inculcate a body of knowledge but also to guide a process of discovery on the part of the students.

Carin and Sund (1964, p. 91) hold that enquiry learning designates an approach whereby the learner proceeds to perform problem solving and gives birth to generalizations by using facts, materials and events which the learner has synthesized on his own, and in his own way. This results in an outcome of newly gained knowledge (new at least to the learner). In this operation a heavy reliance is placed upon the learner's questioning as opposed to direct exposition. The teacher may conduct the experiment or demonstration, but questions must abound. Regarding this the authors state:

> Through such questioning in the process of doing a demonstration or experiment, the teacher is able to direct students' reactions to the whole problem solving process: analyzing problems, making hypotheses, recalling pertinent

> and previously learned knowledge, making tentative conclusions, and finally coming away with a tentatively final conclusion based upon the available data.

Others who have written on this topic in an analogous way include Kersh and Wittrock (1962, pp. 461-468), Bruner (1961, pp. 21-32) and Taba (1963, pp. 308-316).

Through the enquiry process then, knowledge is ferreted, existing data is salvaged, reorganized and utilized in such a manner so that new knowledge is obtained. As an outcome of this, additional material is incorporated into existing conceptual schemes, or, if the material is incongruous to existing generalizations then the latter must be altered so as to encompass the additional data. This activity is what Piaget (in Adler, 1963, p. 1) labels as "assimilation" and "accommodation". Conceptual growth increases as a result of this "equilibration" between assimilation and accommodation.

In the process of learning, each new perception of an event is seen in a different light as the cognitive structure has been altered somewhat by a preceeding perception. This can continue until a sudden insight occurs. Man thus learns through his own responses, which arise in part from selectively organized stimuli and in part by the creation of a new organized whole. In this action the human is not a passive agent and learning therefore assumes an active process of selection and organization of input.

This manner of learning, in which students have the freedom to practice, test and enquire, and wherein answers are not simply given, will allow the learning situation to proceed in a way in which Taba (1962, pp. 308-316) claims will be:

> ... helping learners get at the structure or at the laws and principles of a subject, by allowing them to discover these laws and principles through intensive exploration of concrete instances; ... defining the process of learning as an active organization and reorganization of mental schemata with which to process information and to perceive relationships; strengthening the process of inference, that is, the process of going beyond that which is given.

With regard to the educative process, the chief outcome of this type of concept of learning is to place the child in an environmental situation wherein he is allowed to do his own learning. The effectiveness of enquiry learning therefore hinges greatly upon placing the child in situations wherein he must answer his own queries. This is meant in the broad sense that the child tries things out for himself to see what happens. He therefore engages in manipulative sets involving physical items as well as symbols, poses questions and seeks answers. The answers which are determined at one time are reconciled with those at another time, and also with those found by other children. Some of these views are voiced by Piaget (1964, p. 3) when he states:

> The pedagogical idea is that children should be taught the unifying themes of a subject matter area, after which they will be able to relate individual items to this general structure. (This seems to be what Bruner often means by "teaching the structure").
>
> The question comes up whether to teach the structure, or to present the child with situations where he is active and creates the structures himself ... The goal in education is not to increase the amount of knowledge, but to create the possibilities for a child to invent and discover. When we teach too fast, we keep the child from inventing and discovering himself ... Teaching means creating situations where structures can be discovered; it does not mean transmitting structures which may be assimilated at nothing other than a verbal level.

As seen by Eisner (1965, pp. 624-634) an important basis underlying classroom enquiry is that students should ask questions. In this article he expressed the view that when a unit of study is completed then:

> Hopefully just as many questions or more would be raised in their minds as when they began the study. If the questions are catalytic to further enquiry, and there is every reason to believe that they are, then it seems that one of the teacher's tasks is to develop instructional strategies that elicit important and relevant questions as the students proceed through their individual enquiries.

This statement and many others, which are to be found in the literature, stress the point that the teacher should not make the child's mental schemes, but rather that an opportunity should be given to the learner to form and correct his own thoughts.

An extensive three year study of enquiry in the elementary classroom was carried out by J. Richard Suchman. Suchman (1962, pp. 4-12) regards discovery to consist of four main types of action involving:

(a) Searching signifies a planned and controlled intake of data on the part of the observer. The objective is to secure information of a particular type, at a specific time and in a sequence which results in the maximum value in the formulation and evaluation of ideas.

(b) Data Processing involves the arrangement of data so as to alter the information into systematic and simpler patterns thereby allowing for any relationships present to be more readily discernible.

(c) Discovery refers to an experience occurring to an individual when a sudden assimilation of perceived information fits into a conceptual framework. It is immaterial if this assimilation was brought about by a reorganization of the mental system or of the data.

(d) Verification involves testing the conceptual system by checking to affirm that all of the data which is supposed to be incorporated into the scheme is in fact accounted for.

No one section of this act is unique in itself. All of the components are essential and as a unified approach a cycle of operations results which characterizes the enquiry process. In the evolution of this process the learner is to develop a base of operations for the "investigations of causal relationships".

Within data processing Suchman (1962, p. 7) holds four aspects to occur, all of which perform major roles. These are:

1. Analysis - this is the act whereby complexities are dissected into components.

2. Comparison - in this operation the differences or similarities of various elements are discernible when they are brought together.

3. Isolation - herein variables are separated into smaller groups and thereby allow greater attention to be focussed on each aspect independently.

4. Repetition - by frequent juxtaposition of variables upon each other the probability of recognizing relationships is increased.

It can be seen from this that the learner possesses mobility to search, compile and manipulate information derived from various sources. This, it would appear, seems to indicate that the learning of a process does occur even though this may not be the main

objective in forming the generalization. The net result is that not only does the learner obtain the product of his endeavor, but, also an acquaintanceship with an approach involving inductive reasoning wherein observations are synthesized into meaningful relationships.

In order to analyze and assess growth in the enquiry process Suchman (1962, pp. 35-46) devised a means of measurement based upon the number of questions asked (fluency) and also upon the frequency of specific functional type questions. The fluency score becomes a measure of the number of independent operations performed by the student. This Suchman has tended to regard "as an index of autonomy since each question is an act of initiation and not a response".

The functional type questions are placed into a mutually exclusive hierarchical arrangement of categories which Suchman has organized as follows:

<u>Suchman Categories</u>

A. VERIFICATION

1. Categorical
   - i. Nominal
   - ii. Normative
2. Analytical
   - i. Condition-descriptive
   - ii. Condition-comparative
   - iii. Structural-component
   - iv. Properties check

B. IMPLICATION

1. Abstract-conceptual
   - i. Diffuse
   - ii. Directed

2. Concrete-inferential

i. Elimination
ii. Substitution
iii. Addition

3. Concrete-conceptual

A. Verification Questions

These questions are used to identify parameters such as objects, events and conditions which are present in the problem episode. These apply only to aspects used in the film and are divided into two main sub-categories.

1. Categorical Verification

This involves the identification of events and objects of a problem by assigning them to classes. There are two main subtypes.

i. Nominal: The nominal question serves to identify the class the object belongs to. (e.g., "Was that a rubber balloon?")

ii. Normative: The normative question classifies the object or event to the norm of the class. (e.g., "Was that an ordinary rubber balloon?")

2. Analytical Verification

Subsumed by this category are questions used to analyze objects or events in terms of component parts, properties, conditions, and relationships. This group contains four subcategories.

i. Condition-descriptive: This refers to that type of question used to identify specific quantitative or qualitative conditions. (e.g., "Was that liquid hot?")

ii. Condition-comparative: These questions are used to specify a relationship between two conditions. (e.g., "Was the temperature of the liquid lower when it boiled the second time than when it boiled the first time?")

iii. Structural-component: These questions are used to determine the relationship between parts of a structural whole. (e.g., "Was the blade half one metal and half another?")

iv. Properties check: These are questions which verify the properties of an object. (e.g., "Could the bunsen burner melt the knife?")

B. Implication Questions

This forms the second major category and is used in order to classify questions which search for relationships between variables.

1. Abstract-Conceptual Implication

Within this category are questions which record the attempts of the enquirer to hypothesize relationships between variables. There are two main types of questions within this subtype.

i. Diffuse: This question does not specify the nature of the relationship. (e.g., "Did the cloth have anything to do with the knife bending?")

ii. Directed: In this question the nature of the relationship is specified to a greater extent. (e.g., "Did the knife bend because of unequal expansion of the metal?")

2. <u>Concrete-Inferential Implication</u>

This section of implication questions is concerned with manipulation of variables in order to obtain concrete data. The data then allow the student to make inferences about relationships among the variables. There are three sub-types according to the manner of manipulation involved.

i. Elimination: These are questions which <u>eliminate</u> an object so as to determine the effect on the outcome of the experiment. (e.g., "Would the water have boiled the second time if the cork was not used at all?")

ii. Substitution: These are questions which allow one object or condition in the experiment to be replaced by another. (e.g., "Would the result of the experiment have been the same if hydrogen gas was used in the balloon instead of ordinary air?")

iii. Addition: In addition, new objects are included to determine the effect on the outcome of the experiment. (e.g., "Would the result of the experiment be the same if a glass marble was placed into the balloon?")

3. <u>Concrete-Conceptual Implication</u>

This last category encompasses those questions in which the student attempts to determine the <u>necessity</u> of an object or condition for the occurrence of the phenomenon. (e.g., "Was it necessary to wipe the knife with the cloth?")

II. RESEARCH STUDIES

The following results were obtained from Suchman's study, (pp. 76-81):

1. The sixth grade enquiry group's achievement in physical science concepts was as high as, or better than, the conventionally taught control groups, despite the greater emphasis on content in the latter.

2. On the basis of a time element, the enquiry approach is less efficient than the expository approach, but where maximum conceptual growth is desired, coupled with minimum time consumption, some combination of exposition and enquiry is indicated.

3. The enquiry group was more fluent in questioning.

4. More analytical questions were asked by the enquiry group than by the control group.

5. The enquiry group used less abstract conceptual questions, particularly of the diffuse type, than the control group did.

6. Both groups made extensive use of concrete inferential questions.

In commenting upon these findings, it should be noted that it is hardly surprising to find the enquiry group more fluent than the control group. An important finding, however, exists in the types of questions asked. Those children in the enquiry section asked more analytical questions, which would appear to reflect a more intensive probing behaviour.

Suchman did not pursue the effects of this process on mental operation in children. In an endeavor to determine whether this mode

of enquiry substantially altered the mental behaviour of children Scott, (1964, pp. 7-16), found that among the enquiry groups inductive reasoning in Grade V, and styles of categorization in Grade VI, were related to science concept achievement. This finding implied that age was a factor to be considered.

In a subsequent study, Scott (1966, pp. 143-153), using a modified form of Suchman Inquiry, attempted to determine further factors relating to problem-solving. His study involved three hundred children in Grades IV, V, and VI. The following findings were reported:

The conceptual processes of the groups taught by enquiry were significantly different from those of conventionally taught students. Stylistic preferences of the enquiry group could be related to specific aspects within the problem-solving strategy used in the lessons. Enquiry encouraged an exploratory attitude on the part of the students leading them beyond the overt perceptual phenomena.

Sex differences were significant. In Grades IV and V girls showed greater capability of shifting their attack in arriving at a solution to a problem than did boys. Two possible reasons were advanced for this. Either girls are more advanced in their cognitive capacities than are boys, or the boys may react adversely to a verbally oriented task. At the Grade VI level this gap between the sexes had narrowed.

Studies using the verbal medium have been directed at the Grade V and VI levels (Suchman, 1962). The theoretical framework for such a

choice was established by Jean Piaget. The latter claimed that the onset of formal operations occurs in the late elementary years. Ivany (1965, p. 47) suggests that though the formal operations may develop earlier, the verbal skills necessary to communicate the abstract thought patterns present may not appear until somewhat later.

Gallagher (1967, pp. 8-18) reports a study involving six classes of high ability students studying the BSCS Blue Version, Molecules to Man. A factor investigated in the study involved the "expressive" and "non-expressive" students. Three of the most expressive and least expressive boys and girls were chosen from each class. These people were chosen on the basis of the number of lines spoken by the students, as obtained from a tapescript of data recorded during the class period. When more than three students were non-expressive, the choice was based on alphabetical order. The following results were obtained from this study.

1. Expressive students had a higher mean aptitude score than did the non-expressive ones. For girls this was significant at the 0.05 level, but, failed to attain this level for boys.

2. There were significant differences favoring expressive boys over those being non-expressive when the teacher made test was used as a criterion. The result was in the same direction for girls, but, failed to attain statistical significance.

3. Using a BSCS test, a highly significant difference was found favoring expressive over non-expressive boys. The same trend was observed for girls, but, failed to achieve the 0.05 level of significance.

4. An analysis of variance was performed on the BSCS test results for all members of the six groups. This failed to detect any significant difference between either boys or girls, or between classes.

5. The number of lines of tapescript contributed for each topic in each classroom was compared for girls versus boys. Boys contributed significantly more verbal activity in four classrooms than the girls did.

In reference to the result labelled number 3 above Gallagher (1967, p. 16) states;

> These results would seem to indicate that students who participate verbally in the class discussion were generally better students than those who did not participate. It is thus not a matter of students talking to hear themselves talk, but means that the students who are talking do seem to have a greater grasp of biological concepts as measured by the BSCS test than do those who remain silent.

Regarding expressiveness, or lack of same, between girls and boys the suggestion is made that;

> ... girls are not inferior to boys in thinking ability but for some reason, which likely has a social-sex role basis, do not feel free to communicate ideas in the public forum of the usual classroom discussion.

Gallagher's (1967, pp. 8-18) study provides information regarding characteristics of students who speak up in class. As he states (p. 17);

> In this study there was no question but that those students who were constant participants in class discussion were superior students to those who did not participate. They were not merely talking to hear themselves talk. They did reveal that they had an informational fund and the thinking ability to hold meaningful interchanges with the instructor. At the same time there was a substantial number of students in every class who were mute, or nearly so, in the three days of discussion.

It would appear, though, that certain limitations in the above study would necessitate caution in formulating far reaching generalizations. The study compared only the three most expressive students of each sex in each class with the least expressive. As the latter choice was made on an alphabetical basis in some classes a number of "mute" students had no chance to be chosen. It would be informative to know if the same conclusion would result had the sample been chosen differently.

Biology achievement data was obtained from both teacher - constructed tests and from a BSCS test. A t test was then used to determine significance of achievement between expressive and non-expressive students. Initial aptitude scores had, however, already indicated that the expressive students were more "capable" than were non-expressive students. By using a t test to analyze biology achievement, the initial differential ability between the two groups was not accounted for. It could be informative to determine what the results would have been had initial ability been accounted for.

Craig (1956, pp. 223-234) conducted an experiment to test the hypothesis that increased direction in discovery produces an increase in learning without any loss in either retention or transfer. Two groups, one independent and one directed, were used in the study. The task consisted of solving a common set of problems. The independent group was provided with knowledge of their success in solving the problems. The directed group was given a verbal explanation of the underlying relationships present in the problems. Pre and post tests were used in the study.

The following results were obtained: The group receiving a greater degree of direction learned more relationships. The two groups improved equally in their ability to solve new problems. The general indication from this experiment was that students do derive benefit from help provided during a search for a solution.

A study by Kittle (1957) indicated that an "intermediate" degree of direction during discovery was of greater benefit in helping students learn, retain and transfer than was either "maximum" or "minimum" guidance.

Much support is found in literature (Bruner, 1961, pp. 21-32, Garone, 1960, pp. 104-107, and others) for the view that direct experience with phenomena is a necessary and probably sufficient condition for data to be perceived and become welded into concepts. As an example Bruner (1961, pp. 21-32) suggested that:

> ... the most uniquely personal of all one knows is that which he has discovered himself ... (discovery creates) a special and unique relation between the knowledge possessed and the possessor ... .

In a study by Butts (1963, pp. 135-143) the aforementioned assertions did not receive experimental support. No significant relationship was found between concept development and science achievement scores or chronological age. Butts (1963, p. 141) suggests that further research is required to investigate optimum amount of direction desirable for best concept development.

Butts and Jones report a study (1966, pp. 21-27) involving a total of 109 Grade VI pupils. The sample was split into two groups,

one a control and the other an experimental group involving treatment procedures as devised by Suchman (1960). The study was designed to seek information relating to the following questions:

1. Do children in elementary school, when exposed to guided enquiry designed explicitly to assist in problem-solving behaviour, show behavioural patterns which are indicative of greater effectiveness in solving problems?

2. Is chronological age, sex, or factual knowledge of science related to change, or lack of change, in problem-solving behaviour patterns?

3. Do elementary children, when guided in problem-solving behaviour, exhibit behaviour patterns that indicate meaningful concept development?

Data obtained from the study led the investigators to form the following conclusions:

A significant relationship was apparent between enquiry training and changes in behaviour patterns that are indicative of more effective problem-solving. No significant relationship was apparent between problem-solving behaviour and any of the following: intelligence, chronological age, sex, or factual knowledge of science.

Ivany (1965), conducted an experiment designed to test the effect which different teaching modes have upon the quality and quantity of verbal enquiry. Using four treatment groups, the teaching ranged from an expositional to hypothetical mode. The relevant variable defining the mode, was the amount of visual and audio data pertaining

to a science problem supplied to the students at the beginning of the enquiry session. The enquiry phase was then conducted, using the Suchman (1962) model.

Results from Ivany's study (1965), indicated that a variation in information input did not alter the proportion of students participating in the enquiry session. It was observed that decreasing the information input led to an increase in questions from those who did participate, but did not induce individuals to begin enquiry. Ivany suggested that (1965, p. 113);

> ... other factors, perhaps closely related to the personality or affective dimensions of student behaviour, are more important determinants of enquiry for particular individuals.

The data indicated that a variation in information input affected the quality of enquiry. Concerning this, Ivany (1965, p. 126), noted that;

> It seems reasonable to conclude that patterns of enquiry are specific to the information processing problem presented to the student. Students seem capable of using all of the verbal functions identified by the Suchman model, but often make inefficient use of them. Some of the functions are used more often by the inquirer than their value would merit, while others are used seldom or apparently for less powerful purposes than they might serve.

Verbal enquiry has, at times, been regarded as belonging to the realm of the gifted. Ivany's study (1965) would tend to oppose this view, as the only predictors of verbal participation were found to be fluency and treatment.

> Measures of ability and aptitude, of previous achievement, and the Q Sort measures of role perception, were all poor predictors of participation in any question category. This was the case whether the type of question concerned the mere naming of the apparatus or the more difficult inferential hypothesis. (p. 121)

An aspect of seemingly major importance to group enquiry occurring in a classroom, relates to social structure. Ivany (1965, p. 123), noted that a group leader appeared to exist. Following a probe by such a person, other students would pose several questions related to the content of the initial question. This points to the importance of a leading probe. In view of this consideration, it thus appears of value, to investigate whether any dependency exists between verbal participation and group dynamics with particular reference to both social and academic popularity within the group.

III. CLASSROOM INTERACTION

The spontaneous behaviour and verbal action occurring within an ongoing classroom is so complex and variable that an accurate description of it is most difficult to obtain. Recently, however, systematic attempts have become prominent in investigating these intricate patterns of ideas found in classroom learning.

A variety of systems designed to analyze pupil-teacher interaction have been developed. These include studies by Smith (1960, pp. 229-241), Aschner (1959), Medley and Mitzel (1958, pp. 86-92), Flanders (1960), Amidon (1963), Bellack (1965), Smith and Meux (1959), Taba and Elzey (1964). These systems basically involve the use of categories which describe classroom activity.

In the present study such classroom activity occurs solely on the part of student's questioning during an enquiry session. Categories which classify the questions are those described by Sucnman, and already reported in Chapter II. (pp. 15-17).

Not all systems of interaction analysis, as this system has been called, have the same purpose. The system in this study is primarily concerned with sequencing of student enquiry as indicated by their questions.

Recording Data

The question categories are recorded by entering tallies in a 12 by 12 matrix (Flanders, 1960, Amidon and Flanders, 1963). As an example, in a sequence of four questions represented by categories 1, 4, 3, 6, a total of three pairs of numbers exist in the following manner:

2nd pair

1 4 3 6

1st pair 3rd pair

The particular cell in which tabulation of a pair of number is made is determined by having the first number in the pair indicate the row and the second number the column. Each pair of numbers overlaps with the previous pair, and each number, except the first and last, is used twice. In the work done by both Flanders (1960) and by Amidon (1963) a category (labelled number 10) designating silence was entered as the first and last number in the record. In addition to completing the record (if it is assumed that each recorded episode commenced and ended with silence) this procedure also permitted the total of each column to equal the total of the corresponding row.

IV. AREAS OF THE MATRIX

Areas of the matrix are shown in Table I.

In both columns and rows cells 1 and 2 denote questions asked to verify categories of objects or events seen in the films. Cells 3 to 6 apply to questions of an analytical verification type. These questions attempt to determine conditions, make comparisons, ascertain structural components and check properties of objects. Abstract conceptual relationships, of both diffuse and directed nature, are signified by cells 7 and 8. Cells 9 to 11 represent questions wherein concrete data is obtained through an experimental manipulation of variables and includes elimination, substitution and addition questions. Finally, cell 12 applies to questions which are asked in order to determine the necessity of an event or occurrence of an event. In summary this matrix is used to represent the Suchman categories of questions, as already outlined in this chapter. Major divisions in the matrix are noted by the heavy lines.

Analyzing the Matrix

In this study analysis of the matrix was based upon the method described by Amidon (1963, pp. 28-30). This procedure utilizes the percentage of total questions asked in the observed classroom situation in each of the question categories. In this study these percentages were calculated for the major divisions indicated in TABLE I. A subsequent study of the matrix, containing the calculated percentages, indicates what type of questions contribute most to the enquiry session.

TABLE I

MATRIX AREAS WITH SUCHMAN CATEGORIES

	1	2	3	4	5	6	7	8	9	10	11	12
1												
2												
3												
4												
5												
6												
7												
8												
9												
10												
11												
12												

As a given cell also indicates what sequence has been followed, some data was available relating to the predominent sequence pattern.

V. SOCIAL RELATIONS

Learning outcomes could be related to social conditions existing in the classroom. Horwitz states that the pupil can be carried along by group social conditions. Writing of the pupil Horwitz (1953, p. 170) states:

> To the degree that he desires and obtains social acceptance from his classroom peers, he will find the group attractive and will respond by accepting the learning goals approved by the class.

Northway and Rooks (1957, pp. 222-227) claim that pupils who are low sociometrically are copiers, while those in a high position are creative in their handling of classroom materials.

In a study by Schulz (1951, p. 88), using stimulated recall technique, it was found that overt verbal behaviour was the source of conscious thoughts in the classroom situation. Conclusions related to this problem in Schulz's study found that:

> ...99% of the conscious thoughts reported were stimulated by overt verbal behaviour occurring in the classroom situation... Most of the thoughts stimulated by the overt verbal behaviour were relevant to the classroom situation. That is, they were within the domain of the ideas being considered, or they were thoughts concerning the classroom itself. Less than 1% of the thoughts stimulated by the overt verbal behaviour were irrelevant.

If verbal statements occuring in a classroom are interdependent, as Schulz's study suggests, then additional information must be known about those students who participate verbally. A previous study, (Gallagher, 1967, pp. 8-18) as already noted in this chapter, has

found that the participants in general are students of higher intelligence. It would be informative to know how social position is, or is not, related to participation and to know some characteristics of high and low position students in both social and academic respects.

Social and Academic Rating

Insights into social and academic rating within a group may be obtained by sociometric means. A varied format coupled with a fluctuation in the number of choices required is found in different sociometric instruments. Gronlund (1959, p. 148), however, states that:

> The reliability of sociometric results based on an unlimited number of choices, on 5 positive choices, and on 3 positive and 3 negative choices is so similar that the selection of which procedure to use should be based on factors other than the slight variation in reliability ... Where only positive choices were used, the five-choice limit produced the most reliable sociometric results.

Northway (1952, p. 5) indicates that in earlier use "negative" choices were included. This procedure, however, was found to cause resentment in the group and has been generally deleted from sociometric forms.

Studies by Hunt and Solomon (as reported by French, 1951, pp. 64-72) indicate that the length of time during which group members have known each other affects sociometric selection. As reported by them, a stabilizing process occurs during the fifth or sixth week after a group has been formed. Stability of selection appears to increase up to this duration and then levels off. Even though individuals may not be acquainted with all of the group members at the

end of six weeks, acquaintance span seems to be unrelated to sociometric status after this duration. It would appear that individuals in a new group achieve their normal acquaintances by this time span, and this in turn contributes to the stability of sociometric choices.

Quantitative Rating

Students can be classified into a category of social (or academic) standing on the basis of Bronfenbrenner's table (as reported in Gronlund 1959, p. 65). This table reports that on the basis of five choices for one criterion the expected, lower and upper limit values are 5, 1 and 9 choices respectively. These values are based upon unweighted sociometric choices and apply to groups containing from ten to fifty people. The reference frame remains fixed within the limits indicated and hence two groups of unequal numbers can be compared. The lower and upper limits are limits of statistical significance of 0.02 and 0.03 levels respectively.

Based upon Bronfenbrenner's reference frame Gronlund (1959, p. 95) outlines the following classification:

Star	9 or more choices
Above average	5-8 choices
Below average	2-5 choices
Neglectee	1 choice
Isolate	0 choices

IV. ENQUIRERS

In studies involving human subjects it is not obvious whether students who participate verbally are truly enquiring or not. The fact that an individual forms a query which is subsequently verbalized does not automatically make this person into an enquirer. There are many other reasons which the student may have had for verbalizing. It may have been an attention seeking device, or the individual may have known the answer and merely wished this to be drawn to the attention of the rest of the class and so forth. In like manner one must not imply that the non-verbal student is automatically a non-enquirer.

It is possible to have the following combination of students:

(a) A verbalizing enquirer,

(b) A verbalizing non-enquirer,

(c) A non-verbalizing enquirer,

(d) A non-verbalizing non-enquirer.

Basically, studies of this nature fall into two categories. In one category a student's learning experience is inferred from the study by means of a test (or tests). In the second category an attempt is made to determine additional information of the nature of the actual experience which the student undergoes.

Studies of the first mentioned category involve a determination of the skill commonly referred to as 'critical thinking', or 'scientific reasoning'. Examples of this type are studies which have been done by Kersh (1962, pp. 65-74), Furst (1950, pp. 215-228), Craig (1958, pp. 223-234) and Scandura (1964, pp. 149-159).

In these studies, as with many others, student learning experiences were not determined directly. Each experience was inferred from analysis of test data.

Studies which lie in the second category are of the nature of those done by Schulz (1950), Gaiers (1951) and Berlin (1965). These studies used a stimulated recall technique as established by Bloom (reported in Schulz, 1950).

In stimulated recall, a taped lesson is played back to the students and is stopped at predetermined intervals. The students are then to recall what they were thinking about at that point in the lesson.

The investigators found that the students did not require any special training for this phase. They also determined that the playback provided sufficient stimuli so that the students could recall the original details. The studies found that recall was 90% or more if interviewed within 24 hours after the classroom experience.

There appear to be some shortcomings in this method. Delayed learning cannot be detected by this mode, as the person's concept may very well have increased in the interim. As such, it is conceivable that the person is putting more into the stimulated recall than was there at the original instance. The student, on the other hand, may have had more on his mind than he can remember, or is <u>willing</u> to disclose.

It is suggested, however, that some data could conceivably be obtained regarding whether a verbalizer is an enquirer, etc. It may be

possible to determine when analyzing the written questions submitted by all pupils in Group C (in Chapter III) whether there is a significant difference in the distribution of questions between the non-verbalizers and verbalizers, when the latter make themselves known in the enquiry session. It could be suggested that the foregoing method potentially possesses a much greater 'realiability' in analyzing the problem than does a voluntary request for information involving stimulated recall. Furthermore, as there is no time lag (such as there is in stimulated recall) the data required for the analysis can be obtained immediately.

Teacher Protocol

It should be remembered that teacher protocol is crucial in this type of study. Each teacher has undoubtedly developed a certain way of teaching. This could be alleviated by presenting subject matter on film so as to be invariant to each class. This type of situation could, by its very novelty, prove to be difficult to the pupils. Pupils have established a "set" so that the presentation and follow-up of material is in a different mode from what Thelen (in Ivany, 1965, p. 41) considers to be a violation of expectations. This type of tendency in a school situation, wherein a particular type of teaching behavior is expected, can loom as a potential problem in any type of experimentation performed with human subjects.

There is at least one counteracting influence in that Grade VIII pupils will in all probability have had at least seven teachers prior to Grade VIII. In Grade VIII they have more than one teacher. On the basis of the number of teachers, the pupils should have become accustomed to different modes of teaching.

Ivany's work (1965, p. 114) provides some insight into this problem. It was found that the group which was exposed to the hypothetical mode of instruction, plus an extra session of instruction to provide practice in asking questions, asked a greater number of questions than the hypothetical mode group which received no additional instruction. This Ivany feels

> ...encourages the explanation that a more appropriate set towards participation was induced by this limited instruction.

With this in mind it is felt that one 'dry run' will 'climatize' the class to the expectations.

The climate or 'atmosphere' which exists in the classroom is an important consideration.

Jensen writing in the 59th N.S.S.E. Yearbook Part II (1960, p. 95) notes that there are four dimensions of the social structure which are important in achieving class involvement. He states these as:

> ...the problem-solving and work relationships established among members of the group, the authority relationships, the social-acceptance relationships, and the social-influence or power relationships among class members.

In the 49th N.S.S.E. Yearbook Part I Hilgard (1950, pp. 61-65) notes that:

> Failure to establish relationships consistent with the learning tasks leads to a decline in motivation and a reluctance to participate in the affairs of the group.

These are factors which hold relevancy, but, the existing conditions in the classroom cannot be altered to suit experimental conditions.

There is a section in Ivany's (1965, pp. 122-124) work which is of relevance here. In this work it was found that the students' perception of their role or of their view of the teacher's perception of their role made no difference either in the quality or quantity of their participation.

In view of the preceding finding it is possible to speculate that maybe student perception of the classroom environment is not as important as one may believe at first thought. In any case, the climate will have to be accepted for what it is and no attempt can be made to alter it.

Travers (1958, p. 450) indicates that,

> In most situations, there is a tendency for human subjects to behave in a way that they feel is expected of them.

By means of a 'dry run' then, it is hoped that the pupils will become aware of what is expected of them and will react accordingly.

This study is an attempt at applied research and does not purport to postulate any new theories. It is more in the nature of a classroom interactions study, and does not attempt to decipher individual mental processes or personality characteristics of the pupils. The Suchman model is not infallible. On the contrary, it does have shortcomings, but for this study it is a very useful model. The emphasis in the current study is the effect which verbalizers in a class have upon non-verbalizers. This model places the onus of verbalization upon the pupils and hopefully keeps the teacher out of it. This is a possible weakness in the model.

One final point should be noted in that the presence of another person and equipment in the room may have an effect. This is unavoidable. In this it is like the Heisenberg Uncertainity Principle of physics in that normal and experimental classroom situations cannot be determined simultaneously.

CHAPTER III

I. SAMPLE, PROCEDURES USED AND FRAMEWORK FOR STUDY

The objective of this chapter is to provide a framework for the study. The sample population, the procedures used, experimental design, and statistical treatment are discussed.

The Sample Population

A sample of twelve classrooms was randomly selected from the population of Grade VIII classrooms in the Edmonton, Alberta,Public School System. By random selection also, these classes in turn were assigned to each of three treatment groups (A, B & C) of four classes each. The total number of students involved was three hundred forty eight. Their distribution by sex, class and experimental group, is shown in Table II.

In order that achievement scores could be used it was necessary for a student to be in attendance for each of the enquiry sessions. Absences for one or more sessions made it impossible to include scores for forty-seven individuals, leaving, therefore a total sample consisting of three hundred one students. The distribution of this sample is shown in Table III.

Filmed Episodes

A number of considerations had to be thought of when choosing the problem films. An attempt was made to choose film material which was related to the present stage of development of the students. At the same time, however, the problems had to be novel to the students, with content not usually contained in a Grade VIII science course. A

TABLE II

DISTRIBUTION OF STUDENTS

Group	A				B				C			
Class	01	02	03	04	05	06	07	08	09	10	11	12
Boys No.	16	10	12	14	16	15	14	14	13	12	16	13
Girls No.	13	19	13	20	16	12	14	12	19	16	12	17
Class No.	29	29	25	34	32	27	28	26	32	28	28	30
Group No.	117				113				118			
Total No.					348							

TABLE III

DISTRIBUTION OF STUDENTS USED IN STUDY

Group	A				B				C			
Class	01	02	03	04	05	06	07	08	09	10	11	12
Boys No.	15	9	11	11	16	12	14	10	12	10	13	12
Girls No.	10	14	11	18	12	10	13	11	18	14	11	14
Class No.	25	23	22	29	28	22	27	21	30	24	24	26
Group No.	99				98				104			
Total No.	301											

check was made with each of the Grade VIII science teachers to determine whether they had taught the particular matter dealt with in the films. None of them had done so. Another feature, previously noted, pertained to disequilibrium created by presentation of the problem. In all three films, separate problems in the area of physics were shown to each treatment group.

The filmed material was contained on silent 8 mm. film loops developed by Science Research Associates Inquiry Development Programme at the University of Illinois. Each film was tested for suitability in a total of four Grade VIII classes, not otherwise connected with the experiment, during the pilot study. It was during this phase of the procedure that mechanical details of classroom recording were dealt with. The films are listed in Appendix B by title and order of presentation.

II. TESTING INSTRUMENTS

A. Sociogram. A sociogram was used in this study to determine the socially popular, as well as the isolated students in the class. As noted in Gronlund (1955, pp. 345-354 , and 1959, p. 148), and in Northway (1952, p. 13), fairly stable data and most reliable results are obtained if five positive choices are allowed on each criteria. Hunt and Solomon (1951, pp. 64-72), further found that sociometric choices become relatively stabilized during the fifth or sixth week after a group has been formed.

Each student was provided with a sheet of paper, and requested to write the names of five classmates with whom he would most like to associate. The sociogram appears in Appendix C.

B. Academiogram. Data obtained from this instrument served to determine the academic rating within the classroom group from which the academic starts and isolates could be identified. The same considerations apply as for the sociogram. The academiogram was tabulated in the form of a matrix as indicated by Gronlund (1959).

C. Verbal Rating Scale. As the investigator did not personally know members of any of the classes, each classroom teacher's assistance was sought in obtaining the degree of questioning which the students engaged in under normal classroom condition. The teacher was asked to rate class members on a five point scale by allotting number one to a person who rarely asked questions up to number five for a person who asked many questions. A Spearman Rho Rank correlation coefficient was then obtained between the teacher's rating and the number of questions which were asked under experimental conditions.

D. Achievement Test. The achievement test was constructed by the investigator with suggestions and assistance provided by the committee. The main purpose of this test was to provide a criterion measure. The test was constructed along the lines of Bloom's Taxonomy (1956). All three tests were multiple choice in format and consisted of ten items each. The content of the three films provided the basis for these tests. Achievement scores for each student were then based upon the composite test consisting of the sum of the three individual tests. Of the thiry items, fourteen items were judged to fall in the

lower category (Knowledge and Comprehension) of Bloom's Taxonomy, and sixteen items were considered to fall into the remaining four categories which, for this study, were labelled as the upper category.

Reliability estimates and item analysis of the tests were carried out in four Grade VIII classrooms not otherwise connected with the experimental data phase of the study. A Kuder-Richardson Formula 20 r was calculated with the item analysis and had a value of 0.76. The achievement test appears in Appendix B.

E. Audio Tapes. The questions asked during each class session were taped, and were subsequently transcribed. In some cases it was impossible to hear the question from the tape and hence it could not be transcribed. The student's identification number is known from the tape, but, the substance of the question itself was in some cases inaudible.

F. Intelligence Test. A Lorge Thorndike Non-Verbal Level 4 Form A test was administered to each student. Lorge and Thorndike (1962, p. 3) contend that the non-verbal test provides "an appraisal of abstract intelligence which is not influenced by specific disability in reading". The Fifth Mental Measurements Yearbook (Buros, 1959, p. 350) describes the test as well designed and comments that the uses recommended for it are reasonable and defensible. The test was used in this study in order to obtain a measure of non-verbal ability.

Reliability estimates (Buros, 1949, p. 487) obtained by alternate forms of the test, range from 0.82 to 0.92.

G. Gates Reading Survey. A Gates Reading Survey Form 3 test was administered to each student in order to obtain a measure of reading achievement.

The Third Mental Measurements Yearbook (Buros, 1949, p. 487) describes the Gates Reading Survey test to be one of the most reliable ones.

Reliability estimates (Buros, 1949, p. 487) obtained by alternate forms of the test, range from 0.82 to 0.92.

H. Suchman Question Analysis. The scheme by which student questions were analyzed along the Suchman Model was given in Chapter II. A check on the investigator's categorization was obtained by having two judges (one a staff member and the other a graduate student) perform an independent categorization of two randomly picked sample lessons. Agreement between all three was 75.7%. Agreement between one judge and the investigator was found to be 88% while the other judge and the investigator agreed in 86.4% of the cases. The lessons used for this purpose and their categorization by all three people are included in Appendix A.

III. TREATMENT PROCEDURE

During the first three meetings with the classes in the experimental phase of the study, the experimenter administered the intelligence test, reading test, sociogram, and academiogram. In addition, the classes were given instructions regarding procedures to follow by means of a 'dry run' of an enquiry lesson. In a previous study, Ivany (1965), had found it advantageous to acclimatize the classes to this relatively novel way of conducting a class.

Following administration of the aforementioned tests and 'dry run', the investigator arranged with the science teachers for three subsequent meetings with each class.

In an endeavor to eliminate teacher differences of presentation, the content material was shown by means of films and the enquiry sessions were conducted by the investigator. The treatments indicated below were each carried out during a regular science period in the school. Each class in the study saw the same three films, but thereafter the procedures differed, as can be seen below. Achievement scores obtained on the individual tests were compiled and a total achievement score was tabulated for each student.

Experimental Design

	Group A				Group B				Group C			
Classes	1	2	3	4	5	6	7	8	9	10	11	12
	F	F	F	F	F	F	F	F	F	F	F	F
	T	T	T	T	E	E	E	E	W	W	W	W
	E	E	E	E	T_B	T_B	T_B	T_B	E	E	E	E
	rT_A	rT_A	rT_A	rT_A					T_C	T_C	T_C	T_C

where F represents a film,
E represents a Suchman type enquiry session,
T_A, T_B, T_C represents an achievement test for a film,
rT_A, represents the same achievement test given as a retest following the enquiry session,
W represents five written questions following the film.

Tests T_A, T_B, and T_C are identical in content for each film, but are labelled in the manner indicated in order to distinguish the groups for analysis purposes.

Description of Treatment Procedures

The initial supply of information was identical to all classes in all three treatment groups. This was accomplished by an eight millimeter silent film.

Treatment A

Following presentation of the film, students in this treatment were given a test based on the film content. This test had three basic aims:

(a) to serve as a guide for the subsequent enquiry,

(b) to provide a covariate control for the group, and

(c) to provide for an analysis of the role which guidance assumes within the enquiry process.

Following the enquiry session the same test was readministered.

Treatment B

Classes in this treatment engaged in completely unguided enquiry. Autonomous enquiring activity was required in order to formulate the problem existing in the film, generate hypotheses, test these hypotheses and then arrive at a conclusion.

Treatment C

In this treatment every student had an opportunity to engage in a degree of self guidance prior to the classroom enquiry session. This was effected by having every student, prior to the enquiry session, write five questions on paper, which were then handed in. These were Suchman variety questions which students would ask regarding material seen in the film. As already indicated in Chapter II, the use

of written questions by students in Treatment Group C served to provide information on enquiring and non-enquiring participants and non-participants.

IV. STATISTICAL TREATMENT

Statistical tests used in this study consisted of a t test, a chi square test of independence, Spearman Rank Correlation Coefficient, multiple linear regression analysis, and the Kolmogorov-Smirnov test.

Interpretations of significance were determined on the probability value p. A value of p less than 0.05 ($p < 0.05$) was interpreted as being significant; that is, significant differences existed between or among sub-groups. In all cases a value of p greater than 0.05 was interpreted as being non-significant.

t Test

A t test was used to check for any significant difference between the means of two independent samples. Attributes and conditions under which a t test may be used are noted in Ferguson (1959, pp. 136-138) and in Guilford (1956, pp. 183-185).

By combining data from two samples, an unbiased estimate of the population variance of

$$s^2 = \frac{(X - \bar{X}_1)^2 + (X - \bar{X}_2)^2}{N_1 + N_2 - 2}$$

is obtained. $\bar{X}_1$ and $\bar{X}_2$ are two sample means based on N_1 and N_2 cases respectively. As deviations are taken separately about the means of the two samples, this results in a loss of two degrees of freedom. The

variance estimate, S^2, is then used to determine the standard error of the difference between the two means. Thus

$$S_{\overline{X}_1 - \overline{X}_2} = \left[(S^2/N_1) + (S^2/N_2)\right]^{1/2}$$

when $S_{\overline{X}_1 - \overline{X}_2}$ is divided into the difference between means, $\overline{X}_1 - \overline{X}_2$ the resulting ratio is indicated by "t" and form a t test.

$$t = \frac{\overline{X}_1 - \overline{X}_2}{S_{\overline{X}_1 - \overline{X}_2}}$$

$$= \frac{\overline{X}_1 - \overline{X}_2}{\left[(S^2/N_1) + (S^2/N_2)\right]^{1/2}}$$

The t test, described here, applies under the assumption that the variable in the population from which the samples have been randomly drawn does not depart grossly from a normal distribution. An additional assumption made is that of homogeneity of variance.

As noted by Hays (1963, pp. 321-322) the normal distribution assumption is not as important as that of homogeneity of variance.

Homogeneity of Variance

As already stated, a t test for the significance of the difference between means assumes equality of population variances. Where this assumption is untenable the aforementioned t test should not be applied. Under this condition, a method of obtaining a t distribution is given by Cochran and Cox (1957, p. 101).

A way of testing for homogeneity of variance is given by Ferguson (1959, pp. 140-142). This uses an F test to measure the significance of the ratio of population variances. Letting S_1 and S_2

represent two variances based on independent samples, the F ratio can be written as either S_1^2/S_2^2 or S_2^2/S_1^2. In practice, the larger variance estimate is placed in the numerator and the smaller in the denominator. This results in measuring only one tail of the F distribution and as a consequence, the level of significance obtained from a table of distributions of F must be doubled.

Chi Square

The statistic chi square (χ^2) is used in those situations wherein a comparison is required between observed and theoretical frequencies.

χ^2 is defined by :

$$\chi^2 = \sum \frac{(O - E)^2}{E}$$

where O represents an observed frequency

and where E represents an expected or theoretical frequency. Expected frequencies were calculated from the marginal frequencies of the contingency tables.

In using χ^2 to test for independence, the expected cell frequencies are those which would be obtained if the two variables are independent of each other.

Spearman Rho Rank Correlation Coefficient

The classroom teacher's verbal rating scale and the number of questions, in rank order, which students asked during the investigation was compared by Spearman's Rho (ρ) with tied ranks (Ferguson, 1959, pp. 179-182). In using this procedure tied ranks are replaced by an average rank. Spearman's Rho is given by:

$$\rho = 1 - \frac{6\sum D^2}{N(N^2 - 1)}$$

where $\sum D^2$ represents the sum of the squared differences between ranks and N the number of pairs of measurements.

<u>Significance of Spearman's Rho</u>

When N equals 10 or greater, it is possible to test the significance of the correlation by using the following t value (Ferguson, 1959, p. 183):

$$t = \rho \left[\frac{N - 2}{1 - \rho^2} \right]^{1/2}$$

This quantity with N - 2 degrees of freedom has a t distribution.

<u>Multiple Linear Regression</u>

Bottenberg and Ward (1963) consider multiple linear regression as, "... the most direct and powerful approach to the effective formulation and resolution of a wide variety of research problems." Its use lies in investigating relationships between a set of independent variables serving as predictors and a dependent variable forming the criterion. Development of high speed computers has made this approach to analysis feasible.

The assumption underlying multiple linear regression is that between a criterion variable (Y) and a set of predictor variables (X_i) there is a linear relationship of the form:

3.1 $\quad Y = A_1X_1 + A_2X_2 + A_3X_3 + A_4X_4 + \ldots + A_nX_n$

where the A_i are weight coefficients. (Bottenberg and Ward, 1963, Ch. 1 & 2).

In very infrequent instances, however, will such a linear combination reproduce the criterion variable Y exactly. A certain amount of error occurs in the prediction. A perfect prediction can thus be only obtained by the addition of an error term, resulting in equation 3.2.

3.2 $\hat{Y}_1 = A_1X_1 + A_2X_2 + A_3X_3 + A_4X_4 + \ldots + A_nX_n + E$

where E represents error.

There are many possible values for the coefficients $A_1 \ldots A_n$. It is evident that if the prediction is to be maximized then the error must become a minimum. In use then, the coefficients are so obtained as to minimize the error sum of squares (ESS), the method being known as the "least squares" procedure. The coefficients obtained in the regression equation are called "least squares weights".

Data may be either continuous or categorial. For categorical data the predictor variable $X_i = 1$ if the subject belongs to a specified category, and if not then $X_i = 0$.

Goodness of fit between observed and predicted values is obtained by a multiple correlation between Y and $\hat{Y}$. Its square, termed the squared multiple correlation (RSQ), represents the proportion of the variance of the criterion accounted for by the predictor as obtained from equation 3.2

Use in Testing Hypotheses

Equation 3.2 predicts the criterion measure when all predictors are included and could be called the full model, or Model 1. In order to investigate the effect of a particular variable, say X_2, a new model,

3.3, is formed. This new model restricts X_2 and is called the restricted model, or Model 2.

3.3 $\hat{Y}_2 = A_1X_1 + A_3X_3 + A_4X_4 + \ldots + A_nX_n + E$

Model 2 provides a squared multiple correlation which is either less than, or equal to, that provided by Model 1. In like manner all predictor variables used in the investigation can be used to obtain a set of squared multiple correlations.

Interactions among variables can be investigated by generating a full and restricted interaction model.

An F ratio is used to determine whether any one variable contributes significantly in obtaining a better prediction. This ratio is defined as:

3.4 $$F = \frac{(R_1^2 - R_k^2)/df_1}{(1 - R_1^2)/df_2}$$

where: R_1 = RSQ of the full model,

R_k = RSQ of the appropriate restricted model,

df_1 = number of linearly independent predictors in the full model minus the number of linearly independent predictors in the restricted model.

df_2 = total number of persons in all groups minus the number of linearly independent predictors in the full model.

The programs used in this study were obtained from the User's Library in the Educational Research Section of the University of Alberta at Edmonton and results calculated by the IBM 7040 computer.

Kolmogorov-Smirnov Two Sample Test

A Kolmogorov-Smirnov two sample test is useful in comparing the distributions of two samples. (Guilford, 1956, pp. 262-267). It can be used to test the null hypothesis that two distributions arose by random sampling from the same population.

An essential step in applying the test is to allocate the observations into categories and then to determine the cumulative proportions in each category. The latter step arrives at a standard form of numerical value which is unaffected by differences in the size of the samples. The absolute value of the differences between the cumulative proportions must then be determined for each category.

The K-S test is applied as a small sample test, when the number of entries in each sample is less than 40, and as a large sample test when the number is greater than 40.

A two-tailed test may be used in testing for a difference between two distributions. This test utilizes the difference between cumulative proportions calculated for each category. For the two distributions to be significantly different at the 0.05 level the difference must exceed the value of

$$1.36 \left[\frac{N_1 + N_2}{N_1 \times N_2} \right]^{1/2}$$

where N_1 and N_2 represent the two sample sizes.

CHAPTER IV

I. RESULTS, ANALYSIS AND DISCUSSION

Class Differences

In classroom studies the schools from which classes are to be obtained are chosen by random selection. Once these have been obtained, the use of a class or classes is often dictated by conditions within the school. For example, it was found that in some schools class periods vary in length between forenoon and afternoon. Due to inadequate length of periods, certain classes were eliminated. Class size was a factor which had to be considered, as inordinately large or small classes had to eliminated. As far as was possible, twelve classes were chosen at random, with the teachers' co-operation. These classes were in turn assigned randomly to three treatment groups of four classes each. At this point there was still no measure available indicating the ability of the students in the chosen classes. As this study dealt largely with participants and non-participants, the treatment procedure had to be administered before it became known who the participants and non-participants were. An I.Q. and reading test, administered to each individual, to serve as a co-variate, could then be analyzed. These data appear in TABLE IV.

As seen from TABLE IV, I.Q. and reading differences between participants and non-participants are significant. The conclusion to be drawn from this is that achievement data should be analyzed by a statistic that takes into account the initial ability of the students.

TABLE IV

MEANS, STANDARD DEVIATION AND t TESTS FOR TREATMENT GROUPS

GROUP	TEST	PARTICIPANTS			NON-PARTICIPANTS			t	PROB.
		N_1	$\bar{X}_1$	σ_1	N_2	$\bar{X}_2$	σ_2		
A	I.Q.	53	118.15	11.65	46	113.15	12.36	2.05	<0.05
A	READING	53	10.20	1.18	46	9.93	1.21	1.10	N.S.
A	COMPOSITE ACHIEVEMENT	53	17.58	4.09	46	16.72	4.07	1.05	N.S.
A	HIGHER CATEGORY ACHIEVEMENT	53	6.09	2.13	46	5.00	2.38	2.39	<0.05
A	LOWER CATEGORY ACHIEVEMENT	53	11.51	2.60	46	11.76	2.42	0.49	N.S.
B	I.Q.	60	111.10	12.01	38	106.11	11.72	2.00	<0.05
B	READING	60	9.65	1.38	38	8.88	1.46	2.61	<0.05
B	COMPOSITE ACHIEVEMENT	60	15.75	3.94	38	13.92	3.01	2.42	<0.05
B	HIGHER CATEGORY ACHIEVEMENT	60	4.48	2.04	38	3.84	1.80	1.57	N.S.
B	LOWER CATEGORY ACHIEVEMENT	60	11.15	2.74	38	10.11	2.40	1.91	N.S.

GROUP	TEST	PARTICIPANTS			NON-PARTICIPANTS			t	PROB.
		N_1	$\bar{X}_1$	σ_1	N_2	$\bar{X}_2$	σ_2		
	I.Q.	47	123.15	10.84	57	117.98	10.80	2.40	<0.05
	READING	47	10.63	1.19	57	10.43	1.33	0.77	N.S.
	COMPOSITE ACHIEVEMENT	47	18.11	3.81	57	16.23	3.96	2.43	<0.05
C	HIGHER CATEGORY ACHIEVEMENT	47	5.55	2.45	57	4.54	2.48	2.06	<0.05
	LOWER CATEGORY ACHIEVEMENT	47	12.51	2.25	57	11.60	2.33	2.00	<0.05

Verbal Participants

As the classes were unknown to the investigator the question arose as to whether those students who asked questions during normal class periods and those who participated in the experiment were in fact the same people? Using a Spearman Rho to analyze the classroom teacher's verbal rating scale and the number of questions asked by each individual it was found that a significant correlation existed between the two measures in eleven of the twelve classrooms. Thus, even though only one person could be acknowledged to ask a question at a given instant, the analysis indicates that the participants were essentially the same people who normally asked questions during class periods.

HYPOTHESIS 1.0

The first hypothesis postulated that no significant I.Q. difference existed between participant and non-participant boys and girls.

Using multiple linear regression approach the following results were obtained, as given in TABLE VI.

Using participation as a predictor in the linear regression model, the sex of the student is not a relevant variable. In Group A, from TABLE V, a significant difference was obtained in I.Q. between girls and boys, when analyzed by a t test. The latter test does not allow for control of participation, which is a relevant factor in this study. As indicated in TABLE V, however, in all groups the mean I.Q. for boys is higher than that for girls. A significant level, as obtained from a t test, is not reached in either Groups B or C in TABLE V.

As obtained from both TABLE IV and TABLE VI, a significant difference exists between I.Q. of participants and non-participants.

On the basis of the analysis the null hypothesis regarding no I.Q. differences between boys and girls is supported, but must be rejected regarding I.Q.'s between participants and non-participants. It is evident that I.Q. is a significant predictor regarding participation, and must be used as a predictor when achievement is analyzed.

TABLE V

MEANS, STANDARD DEVIATIONS AND t TESTS FOR TREATMENT GROUPS

GROUP	TEST	GIRLS			BOYS			t	PROB.
		N_1	$\bar{X}_1$	σ_1	N_2	$\bar{X}_2$	σ_2		
A	I.Q.	53	113.23	12.05	46	118.83	11.77	2.40	<0.05
	READING	53	10.07	1.14	46	10.08	1.27	0.03	N.S.
	COMPOSITE ACHIEVEMENT	53	16.58	4.10	46	17.87	4.00	1.56	N.S.
	HIGHER CATEGORY ACHIEVEMENT	53	5.43	2.34	46	5.76	2.27	0.70	N.S.
	LOWER CATEGORY ACHIEVEMENT	53	11.19	2.53	46	12.13	2.42	1.87	N.S.
B	I.Q.	46	107.89	11.10	52	110.29	12.90	0.87	N.S.
	READING	46	9.34	1.50	52	9.36	1.43	0.07	N.S.
	COMPOSITE ACHIEVEMENT	46	14.37	3.25	52	15.63	4.00	1.69	N.S.
	HIGHER CATEGORY ACHIEVEMENT	46	3.85	1.73	52	4.58	2.11	1.86	N.S.
	LOWER CATEGORY ACHIEVEMENT	46	10.41	2.55	52	11.04	2.72	1.17	N.S.

TABLE V (continued)

GROUP	TEST	GIRLS			BOYS			t	PROB.
		N_1	$\bar{X}_1$	σ_1	N_2	$\bar{X}_2$	σ_2		
	I.Q.	57	119.18	10.40	47	121.70	11.78	1.15	N.S.
	READING	57	10.62	1.23	47	10.39	1.30	0.91	N.S.
	COMPOSITE ACHIEVEMENT	57	16.49	3.97	47	17.79	3.92	1.65	N.S.
C	HIGHER CATEGORY ACHIEVEMENT	57	4.68	2.29	47	5.38	2.72	1.41	N.S.
	LOWER CATEGORY ACHIEVEMENT	57	11.72	2.36	47	12.36	2.26	1.39	N.S.

TABLE VI

CONTRIBUTIONS OF VARIABLES WITH I.Q. AS CRITERION

MODEL	VARIABLES	R^2	df	TEST	MODELS	df	F	PROB.
1	8-11	0.28	4	INTERACTION	1:2	1/297	0.01	N.S.
2	4- 7	0.28	3	SEX	2:3	1/298	1.71	N.S.
3	6- 7	0.22	2	PARTICIPATION	2:4	1/298	4.50	<0.05
4	4- 5	0.22	2					

VARIABLES

1 = participation

2 = I.Q.

3 = sex

4 = boys

5 = girls

6 = participants

7 = non-participants

8-11 = treatment cells

HYPOTHESIS 1.1

This hypothesis postulated no significant reading achievement differences between participant and non-participant boys and girls. No significant differences in reading exist between boys and girls as evidenced from TABLES IV, V, AND VII.

The analysis is not so conclusive between participants and non-participants in TABLE IV. No difference is evident in groups A and C, but, a significant difference is present in group B. In view of these results, it is apparent that reading must be used as a covariate in analyzing achievement.

HYPOTHESES 2.0 to 2.2

These hypotheses postulated no significant difference between participant and non-participant sociometric stars and isolates, when based upon successive criteria of I.Q., reading and achievement.

No evidence, based upon TABLE VIII, is available from this study to reject these hypotheses.

From TABLE VIII it should be noted that the mean I.Q. of participant sociometric stars exceeds the mean of non-participant sociometric stars by 4.93 points, but, does not attain a level of statistical significance. Within the participant group, the mean I.Q. of the stars exceeds that of the isolates by 4.73 points, and almost reaches a level of significance.

With regard to achievement, either composite, higher or lower, no significant differences were found between participants and non-participants when these were divided into stars and isolates. Likewise,

TABLE VII

CONTRIBUTIONS OF VARIABLES WITH READING AS CRITERION

MODEL	VARIABLES	R^2	df	TEST	MODELS	df	F	PROB.
1	8-11	0.19	4	INTERACTION	1:2	1/297	1.26	N.S.
2	4- 7	0.15	3	SEX	2:3	1/298	1.82	N.S.
3	6- 7	0.10	2	PARTICIPATION	2:4	1/298	3.91	0.048
4	4- 5	0.02	2					

VARIABLES

1 = participation

2 = reading

3 = sex

4 = boys

5 = girls

6 = participants

7 = non-participants

8-11 = treatment cells

TABLE VIII

MEANS, STANDARD DEVIATIONS AND t TESTS FOR SOCIOMETRIC DATA

GROUP	TEST	PARTICIPANTS			NON-PARTICIPANTS			t	PROB.
		N_1	$\bar{X}_1$	σ_1	N_2	$\bar{X}_2$	σ_2		
STARS	I.Q.	30	119.13	12.64	25	114.20	13.87	1.35	N.S.
	READING	30	10.28	1.13	25	9.83	1.81	1.10	N.S.
	COMPOSITE ACHIEVEMENT	30	17.43	3.89	25	16.56	4.74	0.74	N.S.
	HIGHER* CATEGORY ACHIEVEMENT	30	5.53	2.26	25	5.12	2.57	0.62	N.S.
	LOWER** CATEGORY ACHIEVEMENT	30	11.97	2.59	25	11.48	2.40	0.70	N.S.
ISOLATES	I.Q.	35	113.60	12.52	23	114.48	13.63	0.25	N.S.
	READING	35	10.11	1.51	23	9.91	1.56	0.47	N.S.
	COMPOSITE ACHIEVEMENT	35	16.51	4.14	23	15.57	3.35	0.90	N.S.
	HIGHER* CATEGORY ACHIEVEMENT	35	5.46	2.35	23	4.74	2.27	1.14	N.S.
	LOWER** CATEGORY ACHIEVEMENT	35	11.09	2.38	23	10.83	2.46	0.39	N.S.

TABLE VIII (continued)

GROUP	TEST	STARS			ISOLATES			t	PROB.
		N_1	$\bar{X}_1$	σ_1	N_2	$\bar{X}_2$	σ_2		
PARTICIPANTS	I.Q.	30	119.13	12.64	35	113.60	12.52	1.74	N.S.
	READING	30	10.28	1.13	35	10.11	1.51	0.51	N.S.
	COMPOSITE ACHIEVEMENT	30	17.43	3.89	35	16.51	4.14	0.90	N.S.
	HIGHER* CATEGORY ACHIEVEMENT	30	5.53	2.26	35	5.46	2.35	0.13	N.S.
	LOWER** CATEGORY ACHIEVEMENT	30	11.97	2.59	35	11.09	2.38	1.41	N.S.
NON-PARTICIPANTS	I.Q.	25	114.20	13.87	23	114.48	13.63	0.07	N.S.
	READING	25	9.83	1.81	23	9.91	1.56	0.16	N.S.
	COMPOSITE ACHIEVEMENT	25	16.56	4.74	23	15.57	3.35	0.82	N.S.
	HIGHER* CATEGORY ACHIEVEMENT	25	5.21	2.57	23	4.74	2.27	0.53	N.S.
	LOWER** CATEGORY ACHIEVEMENT	25	11.48	2.40	23	10.83	2.46	0.91	N.S.

* Higher Category Achievement (Categories 3:00 to 6:00 in Bloom)

** Lower Category Achievement (Categories 1:00 to 2:00 in Bloom)

no differences were found between stars and isolates when divided into participant and non-participant groups.

HYPOTHESES 3.0 to 3.2

The intent of these hypotheses was to investigate I.Q., reading and achievement relating to academiometric stars and isolates. As may be seen from TABLE IX no significant differences, on any of these criteria, are evident between participant and non-participant academiometric stars, nor between participant and non-participant academiometric isolates.

When participating academiometric stars and isolates are compared, however, very significant differences are observed on all criteria. The same result is obtained for non-participating academiometric stars and isolates. It is evident, then, that differences exist between stars and isolates regardless of participation.

Discussion of Hypotheses 2.0 to 3.2

No significant differences were detected on any of the measures used as criteria for categories of individuals included within the sociometric groups used in this study. As these criterion measures dealt either with classroom achievement or mental proficiency, it would suggest that sociometric choices are based upon consideration other than the one used in the study. The measures which were used by the students do not appear valuable as predictors of academic success.

For the academiometric group, participation does not appear to be a valuable predictor of academic success either within groups of stars, or isolates. No significant differences were obtained on any of

TABLE IX

MEANS, STANDARD DEVIATIONS AND t TESTS FOR ACADEMIOMETRIC DATA

GROUP	TESTS	PARTICIPANTS			NON-PARTICIPANTS			t	PROB.
		N_1	$\bar{X}_1$	σ_1	N_2	$\bar{X}_2$	σ_2		
STARS	I.Q.	45	122.11	11.63	19	121.37	11.48	0.23	N.S.
	READING	45	10.04	0.76	19	10.94	1.22	0.39	N.S.
	COMPOSITE ACHIEVEMENT	45	18.69	4.05	19	18.00	4.30	0.60	N.S.
	HIGHER* CATEGORY ACHIEVEMENT	45	6.36	2.13	19	5.68	2.18	1.13	N.S.
	LOWER** CATEGORY ACHIEVEMENT	45	12.22	2.45	19	12.26	2.69	0.06	N.S.
ISOLATES	I.Q.	59	112.15	12.78	79	109.78	12.93	1.06	N.S.
	READING	59	9.50	1.50	79	9.58	1.42	0.35	N.S.
	COMPOSITE ACHIEVEMENT	59	15.56	4.11	79	15.01	3.93	0.79	N.S.
	HIGHER* CATEGORY ACHIEVEMENT	59	4.42	2.05	79	4.27	2.39	0.41	N.S.
	LOWER** CATEGORY ACHIEVEMENT	59	11.12	2.91	79	10.75	2.54	0.79	N.S.

TABLE IX (continued)

GROUP	TEST	STARS			ISOLATES			t	PROB.
		N_1	$\bar{X}_1$	σ_1	N_2	$\bar{X}_2$	σ_2		
PARTICIPANTS	I.Q.	45	122.11	11.63	59	112.15	12.78	4.05	<0.01
	READING	45	11.04	0.76	59	9.50	1.50	6.25	<0.01
	COMPOSITE ACHIEVEMENT	45	18.69	4.05	59	15.56	4.11	3.83	<0.01
	HIGHER* CATEGORY ACHIEVEMENT	45	6.36	2.13	59	4.42	2.05	4.63	<0.01
	LOWER** CATEGORY ACHIEVEMENT	45	12.22	2.45	59	11.12	2.91	2.03	<0.05
NON PARTICIPANTS	I.Q.	45	121.37	11.48	79	109.28	12.93	3.54	<0.01
	READING	45	10.94	1.22	79	9.58	1.42	3.80	<0.01
	COMPOSITE ACHIEVEMENT	45	18.00	4.30	79	15.01	3.93	2.89	<0.01
	HIGHER* CATEGORY ACHIVEMENT	45	5.68	2.18	79	4.27	2.39	2.34	<0.05
	LOWER** CATEGORY ACHIEVEMENT	45	12.26	2.69	79	10.75	2.54	2.29	<0.05

* Higher Category Achievement (Categories 3:00 to 6:00 in Bloom)

** Lower Category Achievement (Categories 1:00 to 2:00 in Bloom)

the criteria within the group of stars who participated and those who did not. In like manner no significant differences were apparent between participants and non-participants within the isolate group.

On all measures, however, significant differences were apparent between stars and isolates whether participating or not.

HYPOTHESIS 4.0

This hypothesis postulated no significant differences in the varied levels of achievement between participants and non-participants, and of treatments, when I.Q. served as a predictor variable. Results of the analysis are tabulated in TABLES X to XII.

Interaction effects were not found to be significant for any levels of achievement serving as criteria, and as such there is no evidence to reject that part of the hypothesis.

With I.Q. serving as a predictor variable, the analysis indicates significant differences in both composite and higher category achievement occurring between participants and non-participants. For these two achievement categories significant differences were also found to exist between treatment groups. No such differences were found in either participation or in treatments when I.Q. was used as a predictor variable for the lower categories. The null hypothesis must, therefore, be rejected when either composite or higher comprising categories 3:00 to 6:00 of Bloom's Taxonomy category achievement served as a criterion measure. No evidence is present to reject the hypothesis when lower, consisting of categories 1:00 and 2:00 of Bloom's Taxonomy category achievement, was used as the criterion.

TABLE X

CONTRIBUTIONS OF VARIABLES WITH COMPOSITE ACHIEVEMENT SCORE AS CRITERION

MODEL	VARIABLES	R^2	df	TEST	MODELS	df	F	PROB.
1	3, 11-16	0.24	7					
				INTERACTION	1:2	2/294	0.61	N.S.
2	3, 6-10	0.24	5					
				PARTICIPATION	2:3	1/296	3.92	<0.05
3	3, 8-10	0.23	4					
				TREATMENT	2:4	2/296	3.11	<0.05
4	3, 6- 7	0.22	3					
5,	4, 11-16	0.22	7					
				INTERACTION	5:6	2/294	0.60	N.S.
6	4, 6-10	0.23	5					
				PARTICIPATION	6:7	1/296	6.30	<0.05
7	4, 8-10	0.21	4					
				TREATMENT	6:8	2/296	3.53	<0.05
8	4, 6- 7	0.21	3					

VARIABLES

1 = participation

2 = treatment groups

3 = non-verbal I.Q.

4 = reading

5 = higher category achievement score

6 = participants

7 = non-participants

8 = treatment A

9 = treatment B

10 = treatment C

11-16 = treatment cells

TABLE XI

CONTRIBUTIONS OF VARIABLES WITH HIGHER CATEGORY ACHIEVEMENT SCORE AS CRITERION

MODEL	VARIABLES	R^2	df	TEST	MODELS	df	F	PROB.
1	3,11-16	0.20	7					
				INTERACTION	1:2	2/294	0.30	N.S.
2	3, 6-10	0.20	5					
				PARTICIPATION	2:3	1/296	5.35	<0.05
3	3, 8-10	0.19	4					
				TREATMENT	2:4	2/296	5.94	<0.01
4	3, 6- 7	0.17	3					
5	4,11-16	0.20	7					
				INTERACTION	5:6	2/294	0.93	N.S.
6	4, 6-10	0.19	5					
				PARTICIPATION	6:7	1/296	7.58	<0.01
7	4, 8-10	0.17	4					
				TREATMENT	6:8	2/296	5.91	<0.01
8	4, 6- 7	0.16	3					

VARIABLES

1 = participation

2 = treatment groups

3 = non-verbal I.Q.

4 = reading

5 = higher category achievement score

6 = participants

7 = non-participants

8 = treatment A

9 = treatmemt B

10 = treatment C

11-16 = treatment cells

TABLE XII

CONTRIBUTIONS OF VARIABLES WITH LOWER
CATEGORY ACHIEVEMENT SCORE AS CRITERION

MODEL	VARIABLES	R^2	df	TEST	MODELS	df	F	PROB.
1	3, 11-16	0.16	7					
				INTERACTION	1:2	2/294	2.19	N.S.
2	3, 6-10	0.15	5					
				PARTICIPATION	2:3	1/296	0.62	N.S.
3	3, 8-10	0.15	4					
				TREATMENT	2:4	2/296	1.25	N.S.
4	3, 6- 7	0.14	3					
5	4, 11-16	0.14	7					
				INTERACTION	5:6	2/294	1.81	N.S.
6	4, 6-10	0.13	5					
				PARTICIPATION	6:7	1/296	1.47	N.S.
7	4, 8-10	0.13	4					
				TREATMENT	6:8	2/296	1.84	N.S.
8	4, 6- 7	0.12	3					

VARIABLES

1 = participation

2 = treatment groups

3 = non-verbal I.Q.

4 = reading

5 = lower category achievement score

6 = participants

7 = non-participatns

8 = treatment A

9 = treatment B

10 = treatment C

11-16 = treatment cells

As evidenced from the weights given in Appendix D, treatment A had the highest adjusted mean and treatment B the lowest on both composite and higher category achievement scores. In the lower category achievement, treatment C had a slightly higher mean score than did treatment A, with treatment B having the lowest mean.

With I.Q. serving as a predictor, the data would indicate that in a composite achievement test, including varied categories as outlined by Bloom, participants gain more through an enquiry session than do non-participants. In similar manner results from guided enquiry are superior to those from unguided enquiry.

The same conclusions are to be drawn for achievement scores in the higher categories.

Analysis of lower category test scores shows no significant differences in either participation, or in treatments. It would appear that either the non-participants gained as much of the knowledge and comprehension items from the enquiry session as did the participants, or, that prior to the enquiry they already possessed as much knowledge as did the participants.

The latter suggestion would appear to obtain supporting evidence from TABLE XIII. Using a t test no significant difference is observed to exist in either pre or post enquiry lower achievement scores between participants and non-participants. In a like manner no significant difference is evident for higher category pre-enquiry test scores between participants and non-participants. A significant difference, however, is observed between the two groups when post-enquiry test scores are analyzed. This data adds evidence to the suggestion that

TABLE XIII

MEANS, STANDARD DEVIATION AND t TESTS FOR TREATMENT A

TEST	PARTICIPANTS			NON-PARTICIPANTS			t	PROB.
	N_1	$\bar{X}_1$	σ_1	N_2	$\bar{X}_2$	σ_2		
COMPOSITE ACHIEVEMENT								
PRE-TEST	53	13.28	4.21	46	12.67	2.62	0.84	N.S.
POST-TEST	53	17.58	4.09	46	16.72	4.07	1.05	N.S.
HIGHER*CATEGORY ACHIEVEMENT								
PRE-TEST	53	3.79	2.35	46	3.41	1.34	0.96	N.S.
POST-TEST	53	6.09	2.13	46	5.00	2.38	2.40	<0.05
LOWER**CATEGORY ACHIEVEMENT								
PRE-TEST	53	9.53	2.65	46	9.28	2.12	0.50	N.S.
POST-TEST	53	11.51	2.60	46	11.76	2.42	0.49	N.S.

TEST	GIRLS			BOYS			t	PROB.
	N_1	$\bar{X}_1$	σ_1	N_2	$\bar{X}_2$	σ_2		
COMPOSITE ACHIEVEMENT								
PRE-TEST	53	12.15	2.73	46	13.98	4.14	2.60	<0.05
POST-TEST	53	16.58	4.10	46	17.87	4.00	1.56	N.S.
HIGHER*CATEGORY ACHIEVEMENT								
PRE-TEST	53	3.43	1.49	46	3.83	2.37	0.99	N.S.
POST-TEST	53	5.43	2.34	46	5.76	2.27	0.70	N.S.
LOWER**CATEGORY ACHIEVEMENT								
PRE-TEST	53	8.74	2.11	46	10.20	2.52	3.10	<0.01
POST-TEST	53	11.19	2.53	46	12.13	2.42	1.87	N.S.

* Higher Category Achievement (Categories 3:00 to 6:00 in Bloom)
** Lower Category Achievement (Categories 1:00 to 2:00 in Bloom)

participants do gain more from an enquiry session at the higher category level than do the non-participants.

HYPOTHESIS 4.1

No difference was postulated in the composite, lower or higher Bloom levels of achievement between participants and non-participants, or among treatment groups, and no interaction effects when both I.Q. and sex served as predictor variables. Results of this analysis are tabulated in TABLES XIV to XVI.

Interaction effects are not found to be significant in any of these tables. There is thus no evidence to reject that part of the hypothesis.

With both I.Q. and sex serving as predictor variables and composite achievement score as a criterion, participation is no longer found to be significant. Treatment, however, remains significant. This indicates that the significance attained by participation in TABLE X was largely a sex factor.

When achievement in the higher categories is used as a criterion, significant differences still exist in both participation and in treatments. Adjusted achievement of participants was superior to non-participants and treatment A results were superior to the other treatments. (Appendix D).

With achievement in the lower categories as a criterion, no significant differences are seen to exist in either participation or in treatments. Sex, however, becomes a relevant variable. As indicated in the WEIGHTS in Appendix D, boys achieved slightly higher in all three

TABLE XIV

CONTRIBUTIONS OF VARIABLES WITH COMPOSITE ACHIEVEMENT SCORE AS CRITERION

MODEL	VARIABLES	R^2	df	TEST	MODELS	df	F	PROB.
1	3, 18-19, 12-17	0.25	8					
				INTERACTION	1:2	2/293	0.59	N.S.
2	3, 18-19, 7-11	0.25	6					
				PARTICIPATION	2:3	1/295	2.40	N.S.
3	3, 18-19, 9-11	0.24	5					
				TREATMENTS	2:4	2/295	3.33	<0.05
4	3, 18-19 7- 8	0.23	4					
				SEX	2:5	1/295	2.17	N.S.
5	3, 7-11	0.24	5					
6	4, 18-19, 12-17	0.25	8					
				INTERACTION	6:7	2/293	0.63	N.S.
7	4, 18-19, 7-11	0.24	6					
				PARTICIPATION	7:8	1/295	2.80	N.S.
8	4, 18-19, 9-11	0.24	5					
				TREATMENTS	7:9	2/295	3.75	<0.05
9	4, 18-19, 7- 8	0.23	4					
				SEX	7:10	1/295	7.33	<0.01
10	4, 7-11	0.23	5					

VARIABLES

1 = participation	8 = non-participants
2 = treatments	9 = treatment A
3 = I.Q.	10 = treatment B
4 = reading	11 = treatment C
5 = higher achievement	12-17 = treatment cells
6 = sex	18 = boys
7 = participants	19 = girls

TABLE XV

CONTRIBUTIONS OF VARIABLES WITH HIGHER CATEGORY ACHIEVEMENT SCORE AS CRITERION

MODEL	VARIABLES	R^2	df	TEST	MODELS	df	F	PROB.
1	3, 18-19, 12-17	0.20	8					
				INTERACTION	1:2	2/293	0.32	N.S.
2	3, 18-19, 7-11	0.20	6					
				PARTICIPATION	2:3	1/295	4.12	<0.05
3	3, 18-19, 9-11	0.19	5					
				TREATMENTS	2:4	2/295	6.02	<0.01
4	3, 18-19, 7- 8	0.17	4					
				SEX	2:5	1/295	0.69	N.S.
5	3, 7-11	0.20	5					
6	4, 18-19, 12-17	0.21	8					
				INTERACTION	6:7	2/293	1.02	N.S.
7	4, 18-19, 7-11	0.20	6					
				PARTICIPATION	7:8	1/295	4.53	<0.05
8	4, 18-19, 9-11	0.19	5					
				TREATMENTS	7:9	2/295	6.11	<0.01
9	4, 18-19, 7- 8	0.17	4					
				SEX	7:10	1/295	3.50	N.S.
10	4, 7-11	0.19	5					

VARIABLES

1 = participation	8 = non-participants
2 = treatments	9 = treatment A
3 = I.Q.	10 = treatment B
4 = reading	11 = treatment C
5 = lower achievement	12-17 = treatment cells
6 = sex	18 = boys
7 = participants	19 = girls

TABLE XVI

CONTRIBUTIONS OF VARIABLES WITH LOWER CATEGORY ACHIEVEMENT SCORE AS CRITERION

MODELS	VARIABLES	R^2	df	TEST	MODELS	df	F	PROB.
1	3, 18-19, 12-17	0.24	8					
				INTERACTION	1:2	2/293	1.56	N.S.
2	3, 18-19, 7-11	0.23	6					
				PARTICIPATION	2:3	1/295	0.21	N.S.
3	3, 18-19, 9-11	0.23	5					
				TREATMENTS	2:4	2/295	0.18	N.S.
4	3, 18-19, 7- 8	0.22	4					
				SEX	2:5	1/295	4.63	<0.05
5	3, 7-11	0.21	5					
6	4, 18-19, 12-17	0.08	8					
				INTERACTION	6:7	2/293	1:23	N.S.
7	4, 18-19, 7-11	0.07	6					
				PARTICIPATION	7:8	1/295	0.01	N.S.
8	4, 18-19, 9-11	0.07	5					
				TREATMENTS	7:9	2/295	2.14	N.S.
9	4, 18-19, 7- 8	0.06	4					
				SEX	7:10	1/295	12.20	<0.01
10	4, 7-11	0.04	5					

VARIABLES

1 = participation	8 = non-participants
2 = treatments	9 = treatment A
3 = I.Q.	10 = treatment B
4 = reading	11 = treatment C
5 = lower achievement	12-17= treatment cells
6 = sex	18 = boys
7 = participants	19 = girls

achievement divisions, but, the difference was not significant, except in the lower categories.

From TABLE XIII, using a t test to compare girls and boys in treatment A, the evidence indicates that boys scored significantly higher in lower category items of the pre-test. This would suggest that boys had more initial knowledge necessary to interpret the films than did the girls. The enquiry session, however, had the effect of increasing the girls' level relative to that of the boys'. At the higher achievement level neither group appears to have possessed substantially more understanding when writing the pre-test.

HYPOTHESIS 4.2

No significant differences in the composite, lower or higher Bloom levels of achievement were postulated between participants and non-participants, or between treatments, or of interaction, when reading served as a predictor variable. Results of the analysis are tabulated in TABLES X to XII.

Interaction effects are not significant, so no evidence is present to reject that part of the hypothesis.

Significant differences are present between participants and non-participants and between treatments, when composite achievement and higher category achievement served as criteria. No significant differences are found to be present when lower category achievement served as a criterion. For all three criteria, mean achievement in treatment A was the highest and treatment B was the lowest. Also, mean achievement of the participants exceeds that of the non-participants for all three criteria. (Appendix D).

HYPOTHESIS 4.3

This hypothesis assumed no achievement differences between participants and non-participants, nor between treatment groups, and no interaction effect when reading and sex served as predictor variables. Results of the analysis are tabulated in TABLES XIV to XVI.

Interaction is not significant for any of the three levels of achievement serving as criteria, and hence there is no evidence to reject that part of the hypothesis.

When the composite achievement test score was used as a criterion, participation was not significant, whereas treatment and sex are significant predictor variables. As seen from Appendix D, the mean score of treatment A is the highest of the three, while that of treatment B is the lowest. The mean achievement of boys is superior to that of girls.

With higher achievement as a criterion variable, significant differences are present in both participation and in treatments. Once again the mean achievement score of treatment A is the highest, while that of treatment B is the lowest. The mean achievement score for participants was greater than for non-participants and higher for boys than for girls.

With lower achievement as a criterion, participation and treatment were not significant predictors, but sex was. Boys achieved significantly higher than did girls.

Discussion of Hypotheses 4.0 to 4.3

Disregarding the sex of the student, differences occur in achievement between participants and non-participants in the composite and higher categories, but not in the lower category. This same result was found when both I.Q. and reading were used as predictors. When sex was also used as a predictor the difference for composite achievement disappeared, but remained for the higher category. TABLE XIII for treatment A illuminates this point further. In the pre-test, the mean higher achievement score for participants exceeded that of the non-participants by 0.38 points and was not significant. In the post-test, however, the excess of participants' score over that of the non-participants was 1.09 points, and was statistically significant. Even though both groups gained in higher achievement scores through the enquiry session, the participants gained more than the non-participants did.

For lower achievement scores participation did not provide either participants or non-participants with a relative advantage. It may be that basic knowledge already known to the students could be an influential factor operative here.

It is reasonable to assume that anyone asking questions is likely to be actively preoccupied with the problem under consideration. Based upon this assumption it is possible that the participants were more actively concentrating and searching for a solution to the problem than were the non-participants. As such, the participants may have been more keenly aware of the questions being asked and were attempting to relate the different ideas posed in the enquiry session. During the

enquiry period as with Ivany's study (1965) it was found that a student would occasionally go back and ask a question which was an expansion of one or more ideas already proposed. It is uncertain as to whether those who were not asking questions verbally were doing it mentally, or were waiting for someone to provide the answer.

Except for lower category achievement, treatments have a significant influence regardless of the predictor variables used in this study.

For the lower category it is possible, as already suggested, that each individual has gained a basic knowledge relating to the filmed material. This knowledge is, therefore, not dependent upon any treatment. For higher achievement, however, the results indicate the desirability of guidance. This result is evident from TABLE XIII for treatment A, and the WEIGHTS in Appendix D, which indicate the progressive effects of guidance. The adjusted mean score in Appendix D shows that a decreasing order of mean scores places the treatments in an A, C to B series. The lowest mean socre of all was obtained on the pre-test for treatment A. This shows that the enquiry session itself had a guiding effect. In treatment C, where everyone was asked to write five questions, and therefore thought about the problem, an element of pre-enquiry "self-guidance" occurred. The group obtaining the highest score, though, was treatment A, which received external guidance.

What was stated in the previous paragraph for higher category achievement applies equally to composite achievement. This test, however, consisting of two levels of achievement, indicates the influence

of the higher category component.

Sex was an important variable for the lower achievement category. As recorded in TABLE XIII boys scored significantly better on the pre-test than did the girls. This suggests that initially the boys possessed more basic knowledge of the subject matter.

HYPOTHESIS 5.0

Using data obtained from treatment A this hypothesis postulated no significant differences in the three levels of achievement scores obtained by participant and non-participant boys and girls and no interaction effects.

Treatment A allowed for a pre-enquiry test as a predictor of post-enquiry test so as to investigate the effect of participation and sex upon achievement. Results of this analysis are tabulated in TABLE XVII. Interaction is not found to be significant. No significant differences were found in either sex or participation when composite test results were used as a criterion. There is, thus, no evidence to reject this part of the null hypothesis.

TABLES XVIII and XIX contain an identical tabulation as TABLE XVII except that the criterion measure is based upon higher and lower achievement categories respectively. In both cases interaction is not significant. In neither of the two achievement categories is sex a significant predictor. Participation is significant for the higher category but not for the lower.

TABLE XVII

PRE-ENQUIRY TEST AS A PREDICTOR OF POST-ENQUIRY TEST IN TREATMENT A WITH COMPOSITE ACHIEVEMENT SCORE AS CRITERION

MODEL	VARIABLES	R^2	df	TEST	MODELS	df	F	PROB.
1	2, 9-12	0.43	5					
				INTERACTION	1:2	1/94	0.06	N.S.
2	2, 5- 8	0.43	4					
				SEX	2:3	1/95	0.10	N.S.
3	2, 7- 8	0.43	3					
				PARTICIPATION	2:4	1/95	0.50	N.S.
4	2, 5- 6	0.43	3					

VARIABLES

1 = participation

2 = pre-test

3 = post-test

4 = sex

5 = boys

6 = girls

7 = participants

8 = non-participants

9-12 = treatment cells

TABLE XVIII

PRE-ENQUIRY TEST AS A PREDICTOR OF POST-ENQUIRY TEST IN TREATMENT A WITH HIGHER CATEGORY ACHIEVEMENT AS CRITERION

MODEL	VARIABLES	R^2	df	TEST	MODELS	df	F	PROB.
1	2, 9-12	0.21	5					
				INTERACTION	1:2	1/94	0.17	N.S.
2	2, 5- 8	0.21	4					
				SEX	2:3	1/94	0.05	N.S.
3	2, 7- 8	0.21	3					
				PARTICIPATION	2:4	1/95	4.61	<0.05
4	2, 5- 6	0.17	3					

VARIABLES

1 = participation

2 = pre-test

3 = post-test

4 = sex

5 = boys

6 = girls

7 = participants

8 = non-participants

9-12 = treatment cells

TABLE XIX

PRE-ENQUIRY TEST AS A PREDICTOR OF POST-ENQUIRY TEST IN TREATMENT A WITH LOWER CATEGORY ACHIEVEMENT AS CRITERION

MODEL	VARIABLES	R^2	df	TEST	MODELS	df	F	PROB.
1	2, 9-12	0.48	5					
				INTERACTION	1:2	1/94	0.14	N.S.
2	2, 5- 8	0.48	4					
				SEX	2:3	1/95	0.0001	N.S.
3	2, 7- 8	0.48	3					
				PARTICIPATION	2:4	1/95	1.23	N.S.
4	2, 5- 6	0.47	3					

VARIABLES

1 = participation

2 = pre-test

3 = post-test

4 = sex

5 = boys

6 = girls

7 = participants

8 = non-participants

9-12 = treatment cells

HYPOTHESIS 5.1

Significant differences in the various levels of achievement scores were thought to be non-existent between participant and non-participant boys and girls, when both I.Q. and pre-test were used as predictor variables for treatment A. Results of the analysis for this hypothesis are tabulated in TABLES XX to XXII.

As in previous cases, interaction effects are non-significant.

On the basis of the reported analysis neither sex nor participation are significant predictors for any of the three achievement levels. It should be noted, though, that in TABLE XXI participation is almost significant on the higher category achievement score. There is thus no evidence to reject this hypothesis.

HYPOTHESIS 5.2

It was postulated that no significant differences in the three levels of achievement scores existed between participant and non-participant boys and girls when reading and pre-test were used as predictor variables in treatment A. No significant interaction effects were also assumed. Results for this hypothesis are tabulated in TABLES XX to XXII.

Interaction effects were not found to be significant.

Neither sex nor participation were found to be significant predictors on any of the three levels of achievement serving as criterion variables.

TABLE XX

CONTRIBUTIONS OF VARIABLES IN TREATMENT A
WITH COMPOSITE ACHIEVEMENT SCORE AS CRITERION

MODEL	VARIABLES	R^2	df	TEST	MODELS	df	F	PROB.
1	2, 4, 11-14	0.50	6					
				INTERACTION	1:2	1/93	0.06	N.S.
2	2, 4, 7-10	0.50	5					
				SEX	2:3	1/94	0.60	N.S.
3	2, 4, 9-10	0.49	4					
				PARTICIPATION	2:4	1/94	0.04	N.S.
4	2, 4, 7- 8	0.50	4					
5	3-4, 11-14	0.50	6					
				INTERACTION	5:6	1/93	0.002	N.S.
6	3-4, 7-10	0.50	5					
				SEX	6:7	1/94	0.0001	N.S.
7	3-4, 9-10	0.50	4					
				PARTICIPATION	6:8	1/94	0.11	N.S.
8	3-4, 7- 8	0.50	4					

VARIABLES

1	= participation	7	= boys
2	= non-verbal I.Q.	8	= girls
3	= reading	9	= participants
4	= pre-test, total achievement	10	= non-participants
5	= post-test, total achievement	11-14	= treatment cells
6	= sex		

TABLE XXI

CONTRIBUTIONS OF VARIABLES IN TREATMENT A WITH HIGHER CATEGORY ACHIEVEMENT SCORE AS CRITERION

MODEL	VARIABLES	R^2	df	TEST	MODELS	df	F	PROB.
1	2, 4, 11-14	0.30	6					
				INTERACTION	1:2	1/93	0.01	N.S.
2	2, 4, 7-10	0.30	5					
				SEX	2:3	1/94	0.72	N.S.
3	2, 4, 9-10	0.29	4					
				PARTICIPATION	2:4	1/94	3.01	N.S.
4	2, 4, 7- 8	0.28	4					
5	3-4, 11-14	0.30	6					
				INTERACTION	5:6	1/94	0.03	N.S.
6	3-4, 7-10	0.30	5					
				SEX	6:7	1/94	0.01	N.S.
7	3-4, 9-10	0.30	4					
				PARTICIPATION	6:8	1/94	3.63	N.S.
8	3-4, 7- 8	0.28	4					

VARIABLES

1 = participation	7 = boys
2 = non-verbal I.Q.	8 = girls
3 = reading	9 = participants
4 = pre-test, higher category	10 = non-participants
5 = post-test, higher category	11-14 = treatment cells
6 = sex	

TABLE XXII

CONTRIBUTIONS OF VARIABLES IN TREATMENT WITH A LOWER CATEGORY ACHIEVEMENT SCORE AS CRITERION

MODEL	VARIABLES	R^2	df	TEST	MODELS	df	F	PROB.
1	2, 4, 11-14	0.52	6					
				INTERACTION	1:2	1/93	0.56	N.S.
2	2, 4, 7-10	0.52	5					
				SEX	2:3	1/94	0.08	N.S.
3	2, 4, 9-10	0.52	4					
				PARTICIPATION	2:4	1.94	2.54	N.S.
4	2, 4, 7- 8	0.51	4					
5	3-4, 11-14	0.52	6					
				INTERACTION	5:6	1/93	0.24	N.S.
6	3-4, 7-10	0.52	5					
				SEX	6:7	1.94	0.09	N.S.
7	3-4, 9-10	0.52	4					
				PARTICIPATION	6:8	1.94	2.18	N.S.
8	3-4, 7- 8	0.51	4					

VARIABLES

1 = participation	7 = boys
2 = non-verbal I.Q.	8 = girls
3 = reading	9 = participants
4 = pre-test, lower category	10 = non-participants
5 = post-test lower category	11-14 = treatment cells
6 = sex	

Discussion of Hypotheses 5.0 to 5.2

With pre-test, I.Q. and reading as predictor variables, no marked difference in achievement was apparent between boys and girls. As shown in TABLE XIII initial differences present in the pre-test had disappeared on the post-test. Evidently, the guidance provided was sufficient to cause any differences to become insignificant.

Differences between participants and non-participants were not found to be significant for either composite or lower category achievement.

With the pre-test used as a predictor of post-test achievement a significant difference was obtained for higher achievement between participants and non-participants. With the inclusion of I.Q. and reading as predictors, this difference, becomes non-significant.

HYPOTHESES 6.0 and 6.1

These two hypotheses postulated that verbal participation in the classroom is independent of both sociometric and academiometric position.

Based on analysis given in TABLE XXIII, participation is seen to be independent of sociometric position. Thus, there is no evidence to reject hypothesis 6.0.

From TABLE XXIV, the hypothesis of independence of verbal participation and academiometric position must be rejected. More stars participated than would have been expected under the assumption of

TABLE XXIII

PARTICIPATION AND SOCIOMETRIC POSITION

NUMBER OF PERSONS OBSERVED AND (EXPECTED) IN EACH CELL

	PARTICIPANTS	NON PARTICIPANTS
STARS	30 (31.6)	25 (23.4)
ISOLATES	35 (33.4)	23 (24.6)

$\chi^2 = 0.370$, df = 1, N.S.

TABLE XXIV

PARTICIPATION AND ACADEMIOMETRIC POSITION

NUMBER OF PERSONS OBSERVED AND (EXPECTED) IN EACH CELL

	PARTICIPANTS	NON-PARTICIPANTS
STARS	45 (33.0)	19 (31.0)
ISOLATES	59 (71.0)	79 (67.0)

$\chi^2 = 13.18$, df = 1, $p < 0.001$

independence. In like manner, fewer isolates participated than would have been expected if the two factors were independent.

HYPOTHESIS 7

TABLE XXV contains an analysis pertaining to sex and participation. The results indicate that the assumption of independence must be rejected. More boys and fewer girls participated than would be expected were sex and participation to be independent.

Discussion of Hypotheses 6.0, 6.1 and 7

Previously in this study it was seen that sociometric choices were not based upon academic achievement in the classroom. In data relating to Hypothesis 6.0 there is no evidence to suggest that a student's circle of friends is connected with classroom participation. It would thus appear that friendship between students is based upon considerations other than classroom activities. Seemingly, therefore, school success is not likely to be enhanced by student-student social acquantanceship.

Academiometric position and participation cannot be considered to be independent of each other. In general, more stars and fewer isolates tend to participate than would be expected under an assumption of independence.

From this study sex and participation could not be regarded as independent factors. More boys and fewer girls participated than would be expected were these two factors to be independent. As suggested by Gallagher (p. 17, 1967) a social reason may be operative here. Girls may not feel as free to express themselves in a classroom as do the boys, at least in this subject field. In addition, in this study it was

TABLE XXV

PARTICIPATION AND SEX

NUMBER OF PERSONS OBSERVED AND (EXPECTED) IN EACH CELL

	PARTICIPANTS	NON-PARTICIPANTS
BOYS	98 (77.1)	47 (67.9)
GIRLS	62 (82.9)	94 (73.1)

$\chi^2 = 23.39$, df = 1, $p < 0.001$

found that boys achieved significantly better in the lower achievement categories than did girls. This difference in background of knowledge may also have had an inhibiting effect in decreasing participation by girls.

HYPOTHESIS 8.0

This hypothesis speculated that written questions by participants and non-participants in treatment C would have a similar distribution along Suchman Categories. Analysis of the data appears in TABLE XXVI.

In order to be significant at the 0.05 level the absolute value of the difference between the two cumulative proportions must exceed the value of

$$1.36 \left[\frac{N_1 + N_2}{N_1 \times N_2} \right]^{1/2} \qquad \text{where } N_1 = 705 \text{ and } N_2 = 855$$

With substitution of the values for N_1 and N_2 the critical value is 0.069.

As recorded in TABLE XXVI, the maximum difference obtained between cumulative proportions is 0.091. As this value exceeds the allowable difference of 0.069 at the 0.05 level, the null hypothesis would have to be rejected. It would appear that the two samples did not arise by random sampling from the same population.

The distribution of questions written by the two groups is significantly different. A perusal of TABLE XXVI reveals that the non-participants had already a total of 27.1% of their written questions in the Categorical Verification Category, as opposed to 22.1% for the participants. At this point, however, the distribution is still

TABLE XXVI

NUMBER, PROPORTION, CUMULATIVE PROPORTION AND DIFFERENCE BETWEEN CUMULATIVE PROPORTIONS OF WRITTEN QUESTIONS CLASSIFIED ALONG SUCHMAN CATEGORIES FOR TREATMENT C

QUESTION TYPE	PARTICIPANTS			NON-PARTICIPANTS			DIFFERENCE*
	NO.	PROP.	CUM.	NO.	PROP.	CUM.	
CATEGORICAL VERIFICATION							
Nominal	132	0.187	0.187	182	0.213	0.213	0.026
Normative	24	0.034	0.221	50	0.058	0.271	0.050
ANALYTICAL VERIFICATION							
Descriptive	249	0.353	0.574	329	0.385	0.656	0.082
Comparative	37	0.052	0.626	42	0.049	0.705	0.079**
Structural	12	0.017	0.643	24	0.028	0.733	0.090**
Properties	40	0.057	0.700	41	0.048	0.781	0.081**
IMPLICATION QUESTIONS							
Diffuse	28	0.039	0.739	42	0.049	0.830	0.091**!
Directed	118	0.167	0.906	80	0.093	0.923	0.017
Elimination	2	0.003	0.909	4	0.005	0.928	0.019
Substitution	27	0.039	0.948	31	0.036	0.964	0.016
Addition	0	0.000	0.948	0	0.000	0.964	0.016
Concrete	36	0.052	1.000	30	0.36	1.000	0.000
TOTALS	705			855			

* Absolute value of difference is given

** Significant difference

! Maximum difference observed

not significantly different. Throughout the Analytical Verification Category, though, there is a significantly different distribution. The maximum difference is attained in the Diffuse subcategory of Implication Questions. Of the total number of questions written by each group, 83.0% of these were, for the non-participants, within the Nominal to Diffuse categories, as compared to 73.9% for the participants, a difference of 9.1%.

The difference between the two groups diminished considerably with the Directed question, the cumulative percentage for the participants being 90.6% and for the non-participants 92.3%, a difference of 1.7%.

On the basis of the analysis this null hypothesis must be rejected.

HYPOTHESIS 8.1

It was considered possible that student questions in all treatment groups would form a similar distribution when classified along Suchman Categories. Analysis of the data for this is reported in TABLES XXVII to XXX.

From TABLE XXVIII, it is seen that the value of 0.083 required for significant difference is exceeded by the value 0.095 between treatments A and B. The significant difference value of 0.086 is not exceeded between treatments A and C, as the maximum difference of 0.039 between the two groups is well below the allowable amount. For treatments B and C the maximum observed difference of 0.108 is more than 0.084, the amount designating a difference in distribution. From

TABLE XXVII

NUMBER, PROPORTION AND CUMULATIVE PROPORTION OF CLASSROOM ENQUIRY QUESTIONS CLASSIFIED ALONG SUCHMAN CATEGORIES FOR TREATMENTS A, B AND C

QUESTION TYPE	TREATMENT A			TREATMENT B			TREATMENT C		
	NO.	PROP.	CUM. PROP.	NO.	PROP.	CUM. PROP.	NO.	PROP.	CUM. PROP.
CATEGORICAL VERIFICATION									
Nominal	49	0.082	0.082	40	0.061	0.061	22	0.051	0.051
Normative	6	0.010	0.092	9	0.014	0.075	8	0.019	0.070
ANALYTICAL VERIFICATION									
Description	171	0.285	0.377	226	0.342	0.417	139	0.329	0.399
Comparative	25	0.042	0.419	19	0.029	0.446	25	0.059	0.458
Structural	21	0.035	0.454	40	0.061	0.507	11	0.026	0.484
Properties	54	0.090	0.544	63	0.095	0.602	23	0.054	0.538
IMPLICATION QUESTIONS									
Diffuse	31	0.052	0.596	59	0.089	0.691	19	0.045	0.583
Directed	119	0.198	0.794	54	0.081	0.772	74	0.175	0.758
Elimination	6	0.010	0.804	7	0.011	0.783	11	0.026	0.784
Substitution	61	0.101	0.905	71	0.107	0.890	56	0.132	0.916
Addition	0	0.000	0.905	1	0.002	0.892	0	0.000	0.916
Concrete Conc.	58	0.095	1.000	72	0.108	1.000	95	0.084	1.000
TOTALS	601			661			423		
AVERAGE NUMBER OF QUESTIONS ASKED PER PARTICIPANT		11.3			11.0			9.0	

TABLE XXVIII

ABSOLUTE VALUES OF DIFFERENCE IN CUMULATIVE PROPORTIONS FOR TREATMENTS A, B AND C AND DIFFERENCE REQUIRED FOR SIGNIFICANCE AT 0.05 LEVEL

QUESTION TYPE	TREATMENT A&B	TREATMENTS A&C	TREATMENTS B&C
CATEGORICAL VERIFICATION			
Nominal	0.021	0.031	0.010
Normative	0.017	0.022	0.005
ANALYTICAL VERIFICATION			
Descriptive	0.040	0.022	0.018
Comparative	0.027	0.039!	0.012
Structural	0.053	0.030	0.023
Properties	0.058	0.006	0.064
IMPLICATION QUESTIONS			
Diffuse	0.095*!	0.013	0.108*!
Directed	0.021	0.036	0.015
Elimination	0.021	0.020	0.001
Substitution	0.015	0.011	0.026
Addition	0.013	0.011	0.024
Concrete	0.000	0.000	0.000
DIFF. REQUIRED FOR SIGNIFICANCE**	0.083	0.086	0.084

* Significant difference

** Obtained by substituting totals from TABLE XXVII into expression

$$1.36 \left[\frac{n_1 + n_2}{n_1 \times n_2}\right]^{1/2}$$

! Maximum difference

TABLE XXIX

NUMBER, PROPORTION AND CUMULATIVE PROPORTION OF CLASSROOM ENQUIRY QUESTIONS CLASSIFIED ALONG SUCHMAN CATEGORIES FOR I.Q. EQUATED GROUPS OF TREATMENTS A, B AND C

QUESTION TYPE	TREATMENT A			TREATMENT B			TREATMENT C		
	NO.	PROP.	CUM.	NO.	PROP.	CUM.	NO.	PROP.	CUM.
CATEGORICAL VERIFICATION									
Nominal	33	0.073	0.073	27	0.061	0.061	14	0.046	0.046
Normative	5	0.011	0.084	10	0.023	0.084	5	0.016	0.062
ANALYTICAL VERIFICATION									
Descriptive	124	0.274	0.358	155	0.350	0.434	99	0.325	0.387
Comparative	23	0.051	0.409	12	0.027	0.461	15	0.049	0.436
Structural	17	0.038	0.447	24	0.054	0.515	7	0.023	0.459
Properties	43	0.095	0.542	57	0.129	0.644	17	0.056	0.515
IMPLICATION QUESTIONS									
Diffuse	26	0.057	0.599	26	0.059	0.703	13	0.043	0.558
Directed	101	0.223	0.822	20	0.045	0.748	62	0.203	0.761
Elimination	6	0.013	0.835	7	0.016	0.764	3	0.010	0.771
Substitution	44	0.097	0.932	56	0.126	0.890	36	0.118	0.889
Addition	0	0.000	0.932	0	0.000	0.890	0	0.000	0.889
Concrete	31	0.068	1.000	49	0.110	1.000	34	0.111	1.000
TOTAL	453			443			305		

TABLE XXX

ABSOLUTE VALUES OF DIFFERENCE IN CUMULATIVE PROPORTIONS FOR I.Q. EQUATED GROUPS OF TREATMENTS A, B AND C AND DIFFERENCE REQUIRED FOR SIGNIFICANCE AT 0.05 LEVEL

QUESTION TYPE	TREATMENTS A&B	TREATMENTS A&C	TREATMENTS B&C
CATEGORICAL VERIFICATION			
Nominal	0.012	0.027	0.015
Normative	0.000	0.022	0.022
ANALYTICAL VERIFICATION			
Descriptive	0.076	0.029	0.047
Comparative	0.052	0.027	0.025
Structural	0.068	0.012	0.056
Properties	0.102*	0.027	0.129*
IMPLICATION QUESTIONS			
Diffuse	0.104*	0.041	0.145*
Directed	0.074	0.061	0.013
Elimination	0.071	0.064!	0.007
Substitution	0.042	0.043	0.001
Addition	0.042	0.043	0.001
Concrete	0.000	0.000	0.000
DIFF. REQUIRED FOR SIGNIFICANCE**	0.091	0.100	0.101

* Significant difference

** Obtained by substituting totals from TABLE XXX into expression $= 1.36 \left[\frac{n_1 + n_2}{n_1 \times n_2}\right]^{1/2}$

! Maximum difference

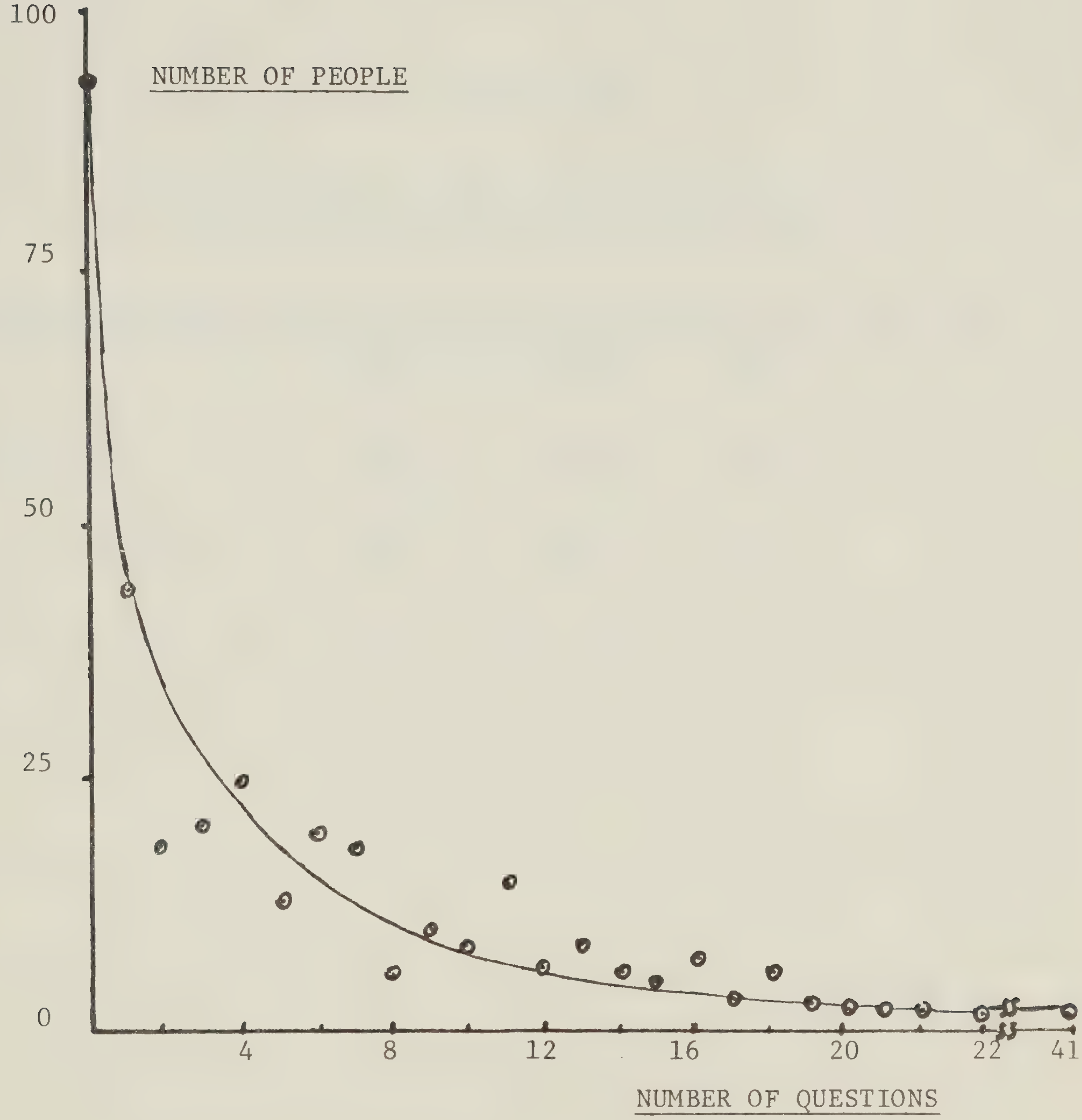
this analysis it is to be concluded that the question distributions along Suchman Categories are significantly different between treatment groups A and B and also between groups B and C, but not between treatment groups A and C.

As recorded in TABLE IV differences occur between the I.Q.'s of the participants in the three treatment groups. It was felt that compensating adjustments should be made so as to have either a statistical control on I.Q., or matching between groups. FIGURE I shows a frequency distribution for fluency of verbal enquiry, which is seen to vary greatly from normality. It was thus impossible to use statistical means to adjust for I.Q. An alternative procedure to statistical adjustment is a mechanical one. It was found that I.Q. could be equated, as shown in TABLE XXXII when three classes were chosen from each of treatments A and C, and two from treatment B.

With no significant differences between I.Q.'s for the sample classes chosen from the three treatments, TABLES XXIX and XXX contain an analysis testing the distribution of questions asked during the enquiry periods. Results identical to those already reported are seen to prevail.

At the 95 percent level of confidence there is no significant difference in question distributions along Suchman Categories between treatment groups A and C. A significant difference, however, exits between groups A and B and also between B and C. The null hypothesis must thus be rejected for the latter two cases. No reason is evident to reject the null hypothesis as applied to treatment groups A and C.

FIGURE I



FREQUENCY DISTRIBUTION FOR
FLUENCY OF VERBAL ENQUIRY

TABLE XXXI

NUMBER OF PARTICIPANTS OBSERVED AND (EXPECTED)

	GROUP A	GROUP B	GROUP C
PARTICIPANTS	53 (52.6)	60 (52.1)	47 (55.3)
NON-PARTICIPANTS	46 (46.4)	38 (45.9)	57 (48.7)

$\chi^2 = 5.225$, df = 2, $0.10 > p > 0.05$

TABLE XXXII

MEANS, STANDARD DEVIATIONS AND t TESTS TESTING FOR I.Q.
BETWEEN REDUCED PARTICIPANT GROUPS A, B AND C

	N_1	$\bar{X}_1$	σ_1	N_2	$\bar{X}_2$	σ_2	t	PROB.
GROUPS		A			B			
	38	120.8	11.30	38	116.9	11.33	1.51	N.S.
GROUPS		A			C			
	38	120.8	11.30	36	120.9	10.30	0.01	N.S.
GROUPS		B			C			
	38	116.9	11.33	36	120.9	10.30	1.56	N.S.

Discussion of Hypotheses 8.0 and 8.1

Using a Kolmogorov-Smirnov two sample test a significant difference in distribution, along Suchman Categories, is noted in the written questions of treatment C. Seventy percent of the written questions of people who ultimately became participants were Verification questions compared to 78.1% for non-participants. The maximum difference between the two groups was attained in Diffuse questions, where the difference was 9.1% (TABLE XXVI). A marked decrease in the difference between cumulative proportions is seen in the Directed Question category. This decrease is due to the participants having written a higher percentage of Directed questions than did the non-participants. 16.7% of all the questions written by the participants were Directed, compared to 9.3% for the non-participants.

The two question categories, Diffuse and Directed, encompass student attempts to hypothesize relationships between variables. Directed questions, however, involve much more risk than do Diffuse ones. Using examples from the enquiry session transcript an example of a Diffuse question, (asked in the film BOILING), is: "Did the ice have anything to do with it?" For the same film an example of a Directed question is: "Did placing the ice on the flask cause a partial vacuum in the flask and allow the water to start boiling again?" Comparing the two questions a student is placing more of his own thoughts into the latter question than into the first, which is a relatively "safe" question to ask.

Although TABLE XXVI shows that the significant difference of 0.069 obtained by the Kolmogorov-Smirnov test, is exceeded throughout

Descriptive to Diffuse questions inclusive, it must be noted that this occurred as a result of a cumulative increase in the difference. Only in the Directed questions has an abrupt change taken place, wherein the difference has altered from 9.1% between Diffuse to 1.7% between Directed questions. If any main conclusions to be drawn from this data it must be that the participants were more willing to ask specific cause and effect questions than the non-participants were.

For Hypothesis 8.1, a significant difference in the distribution of classroom questions was obtained between treatment groups A and B and also between B and C. No such difference was found between A and C, from data recorded in TABLE XXVIII. Three possible questions could be asked about these results. Was the result a function of treatment, or intelligence, or a combination of both? As the questions did not even remotely form a normal distribution (FIGURE I) statistical adjustment of I.Q. could not be used. It was found, however, that by taking three classes from each of treatments A and C and two from treatment B, three groups could be formed such that no significant differences in group I.Q.'s existed (TABLE XXXII). Analysis of data from these three groups yielded the same results as for the complete groups, including all twelve classes; namely, differences between A and B and between B and C were significant, but were non-significant between A and C. (TABLE XXX).

A study of TABLE XXIX, for the I.Q. equated groups, reveals certain salient points. (The same trend is evident from TABLE XXVII, for all twelve classes, though the percentages differ somewhat from those of TABLE XXIX). Of all the questions asked by each group, 54.2%

of those by treatment A dealt with some form of Verification, while treatment B and C students asked 64.4% and 51.5% respectively. Already at this point differences between A and B and also between B and C are significant.

All three treatment groups asked nearly equivalent percentages (5.7, 5.9, and 4.3 for A, B and C respectively) of Diffuse questions. The most outstanding difference, however, exists in Directed questions. These values are: 22.3%, 4.5% and 20.3% for treatments A, B and C respectively. This illustrates that both groups A and C asked much greater percentages of specific cause and effect questions than did group B. It would appear reasonable that group A should ask more of these questions than would group B, as the former had the pre-test as a guide and a source of stimulation. It is not so readily apparent why group C should do this.

It is reasonable to suspect that human motives and aspirations have a bearing upon this result. It was found that for the first few minutes of the enquiry session questioning proceeded at a "furious" pace which gradually diminished. By the end of the enquiry period, relatively long moments of silence were encountered between questions. It is conceivable that some students who wished to ask questions (to participate) just asked a sufficient number until they themselves felt satisfied that they were "on the record", and that their presence was noted. For the satisfaction of this motive it was easier and much safer to ask "Was that water in the beaker?", than to ask "Did the water boil the second time because of ...?" It was found that at times these verification questions were repeated two or three times

during the enquiry period. It is, of course, possible that the student had forgotten the answer, but more probable that the student, wanting to ask some questions, asked a safe one.

At other times questions which had already been answered were simply rephrased and asked again. An example of this is illustrated by the following two questions asked in sequence in a treatment B class;

Student 1: "Was that boiling water in the container?"
ANSWER, Yes.

Student 2: "Was the water boiling?"
ANSWER, Yes.

People in treatment group C may not have felt the same compulsion to ask questions in the other two treatment groups. Data relevant to this point is presented in TABLE XXXI. Though the analysis does not offer any rejection of independence of group treatment and participation, the results are not that conclusive, as the probability value is only slightly higher than 0.05. Only in group A are the observed and expected numbers of participants and non-participants almost identical. In treatment B more people participated than would have been expected, while in treatment C fewer than expected participated. Furthermore, the average number of questions asked per participant was less in treatment C than in any of the other two treatments (TABLE XXVII). It thus appears reasonable to suggest that treatment C students may not have had as great a drive to ask questions as in the other treatments.

Though the drive factor is only a postulate attempting to explain group behaviour, it would appear to have a certain degree of merit. Students in treatment C were given an opportunity to submit questions in writing. This may have had implications which originally

were not considered nor intended. In their own minds some students may have felt that since they had had a personal correspondence with the researcher their questions would be known by him. This in turn may have lessened the drive to ask questions just for the sake of recognition.

The types of questions asked were found to differ as the enquiry period progressed. Questions in each treatment group were divided into three equal parts. In all groups verification questions were more predominant during the first third of the enquiries but decreased progressively as more implication questions were asked in the latter stages of questioning.

In summary, the main conclusions to be drawn for Hypothesis 8.1 are that, on the basis of this study, differences do exist in the Suchman distribution of questions when treatments, as have been described, are used. The outstanding difference is in the percentage of specific cause and effect questions asked by the three treatment groups. The unguided enquiry group asked a significantly higher percentage of Verification questions than either of the other two groups. The latter two groups consequently were more involved in attempting to determine causes to explain the effects seen in the films. By inference the submission of written questions by students in group C may have had an effect in partially satisfying a human need of recognition. A partial satisfaction of this may have been instrumental in reducing the number of people moved to participate, as well as reducing the average number of questions which were asked per participant. It is possible that those which were asked in treatment C, were asked less for personal need satisfaction and more as a result of curiosity to obtain a solution to the problems shown in the films.

CHAPTER V

SUMMARY, CONCLUSIONS, AND IMPLICATIONS

I. SUMMARY

The main aim of this study was to test the effect of verbal participation during enquiry sessions. Other factors investigated were: intelligence characteristics of participants and non-participants, question categories for each treatment group, (for each of the three subject matter films), and categorization of written questions for both participants and non-participants of treatment group C.

The Suchman Model was used to delimit the study. This is a model of enquiry based on information processing. It defines a system of question categories according to the function of the question posed in classroom enquiry. To facilitate categorization, the students were asked to structure their questions so as to receive "yes" or "no" answers. Control of information input was accomplished by viewing a silent film of each of the problems used in the study. All students in the study saw the same three films.

Twelve randomly selected grade VIII classes were used for the study. These were randomly assigned to three treatment groups of four classes each. All treatment groups were first shown a film. In treatment A a test was administered following the filmed presentation. This test consequently served as guidance for the subsequent enquiry session. The remaining two groups, not having the advantage of a pretest, engaged in unguided discovery. Students in treatment C were asked to write five questions on paper, after having viewed a film.

This was to determine whether any detectable differences existed in the categories of questions posed by the two groups consisting of participants and non-participants, during the enquiry session.

Control variables used in the interpretation of the analysis included the following: a Lorge-Thorndike Non-Verbal Intelligence Test Form B, a Gates Reading Survey Level 3, a sociogram, an academiogram and an achievement test. The achievement test was based upon content shown in the films, and was constructed along categories of Bloom's Taxonomy. Sixteen items were in the higher categories of the Taxonomy and fourteen items were in the lower categories. In many cases, statistical analysis was conducted with three separate achievement scores, namely, total achievement based upon the complete test of thirty items, and also achievement based upon higher and lower categories, separately.

II. CONCLUSIONS

It is convenient to group the contents of this section under three headings. The conclusions deal with characteristics of students, test performance and question analysis.

Characteristics of Students

In all treatment groups participants obtained higher mean I.Q. scores than did the non-participants. A significant difference in reading comprehension was obtained between participants and non-participants of treatment group B. No such difference was apparent for either of treatment groups A or C.

No differences in either I.Q., reading performance, or varied levels of test achievement were found between participating sociometric stars and isolates, nor between non-participating stars and isolates. Similarly, no significant differences were obtained in any of the above mentioned criteria between participant and non-participant stars, or between participant and non-participant isolates.

Using I.Q., reading and varied levels of test achievement as criteria, no significant differences were observed between participating and non-participating academiometric stars, or between participating and non-participating academiometric isolates. Markedly significant differences on all criteria were found between participating academiometric stars and isolates, and also between non-participating stars and isolates.

Whether or not a student participated during the enquiry session was found to be independent of sociometric position in the classroom. Participation and academiometric position in the classroom, however, were found to be dependent factors. More stars and fewer isolates participated than would have been expected under an assumption of independence. Sex and participation were, likewise, found to be dependent upon each other, as more boys and fewer girls participated than were expected.

Test Performance

A summary of the results is given in TABLE XXXIII.

Using predictor variables, as listed in TABLE XXXIII, composite and higher achievement scores between groups are significantly affected

TABLE XXXIII

I.Q., READING AND SEX AS PREDICTOR VARIABLES WITH POST ENQUIRY COMPOSITE, HIGHER AND LOWER ACHIEVEMENT AS CRITERIA

PREDICTORS	1	2	3	4	5	6	7	8	9	10	11	12
INTERACTION	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
PARTICIPATION	S	S	ns	ns	S	S	S	S	ns	ns	ns	ns
TREATMENT	S	S	S	S	S	S	S	S	ns	ns	ns	ns
SEX	NI*	NI*	ns	S	NI*	NI*	ns	ns	NI*	NI*	S	S

* Not included as a variable in the analysis.

1. I.Q. serving as a predictor of composite achievement.
2. Reading serving as a predictor of composite achievement.
3. I.Q. and sex serving as predictors of composite achievement.
4. Reading and sex serving as predictors of composite achievement.
5. I.Q. serving as a predictor of higher achievement.
6. Reading serving as a predictor of higher achievement.
7. I.Q. and sex serving as predictors of higher achievement.
8. Reading and sex serving as predictors of higher achievement.
9. I.Q. serving as a predictor of lower achievement.
10. Reading serving as a predictor of lower achievement.
11. I.Q. and sex serving as predictors of lower achievement.
12. Reading and sex serving as predictors of lower achievement.

by treatment procedures. At the lower category of achievement treatments, as used in this study, had no effect upon achievement.

When sex was not included as a predictor variable, participation had a significant effect upon composite achievement. With the inclusion of sex as a predictor, this significance disappeared, indicating thereby more of a sex than participation characteristic. Participation did have an effect in all cases upon higher achievement, regardless of the predictor variables used. At the lower category level, however, it was immaterial whether students participated or not, as no marked differences were obtained when using the predictor variables.

The sex of the student had no bearing upon achievement for the higher category, but was significant for the lower category. Using the different predictor variables, as listed in TABLE XXXIII, boys performed significantly better than girls. Using reading and sex as predictor variables it was found that sex also had an effect upon composite achievement.

Question Analysis

In the analysis of questions written by students in treatment group C, a significant difference is observed throughout the Analytical Verification Category between students who subsequently became participants and non-participants during the enquiry session. Non-participants wrote a higher cumulative percentage of questions in this category. A maximum difference occurred in the next category, Directed, as participants wrote a substantially higher percentage of their questions in this category than did the non-participants.

From analysis of classroom questions no significant differences were evident between treatment groups A and C. Differences were obtained, though, between treatments A and B and also between B and C. In both of these latter cases the maximum difference was present in the Diffuse category (TABLES XXVIII and XXX). Students in treatment group B had asked a significantly higher cumulative percentage of questions to the end of the Diffuse category, than in either of the other two treatments.

Although a test of whether participation and treatment were independent factors barely failed to attain statistical significance, a number of observations can be made (TABLE XXXI). Only in treatment group A are the observed and expected numbers of participants almost identical. In treatment B more people participated than would have been expected, while in treatment C fewer than expected participated.

II. IMPLICATIONS

Group Dynamics

From the data available from this study it would appear that student participation in the classroom is associated with a higher level of achievement. With classroom groups of thirty students it is possible for many students to remain silent if participation is to be left on a voluntary basis. As with Gallagher's study (1961) those who participated in this study possessed a significantly higher I.Q. than did the non-participants. These factors clearly indicate one of the aspects for which a teacher is responsible. Students who shun voluntary participation

should be encouraged to take an active part in the day's lesson. Even if the student's contribution is limited to the most elementary questions in the Suchman scheme presumably such active participation, coupled with perhaps a desire to please, could potentially make the individual more receptive to the queries of others in the classroom.

The difference of I.Q. has an implication for teaching. The non-participants who are encouraged to participate should be provided with verbal tasks which are commensurate with their ability. With direction provided by a teacher the enquiries could become increasingly aimed at a solution to the problem under study. Encouragement of individual inquiry and recognition of the student's ability with this mode rests in the hands of the classroom teacher. It may well be that one of the most important roles of an inquiry teacher is to be a director of group processes.

During an enquiry period a teacher must frequently make value judgments regarding the intent of the question. In this study it appeared that student questions, at times, seemed preoccupied with presenting a correct answer and an attempt to win approval. The teacher's efforts should alter the emphasis to the problem, the search and challenge which the problem poses.

Guidance

Guidance, in this study, was defined as the amount of information given to students prior to the inquiry session. This information

was provided by means of a task oriented process, namely the pre-test to Group A. With adjustment for initial ability, it was found that the highest mean achievement in both the composite and higher category was attained by this group given maximum guidance. The lowest mean achievement was obtained by the group having had no previous task oriented exercise prior to enquiry. This has implications for teaching. It would appear that students require a basis upon which to engage in enquiry, and which enables them to better comprehend the subject matter under enquiry. Perhaps by such actively engaged task processes students are able to assimilate material at other than a verbal level as suggested by Piaget (1964, p. 3). These suggestions are partially borne out by the fact all treatment groups attained almost an identical score on knowledge and comprehension items (lower achievement category). Apparently in these items the effect of guidance is negligible.

The effect which an adequate background of knowledge has upon achievement is well illustrated by sex differences. Girls apparently lacking the same degree of background for the subject matter used in this study, had a significantly lower mean achievement in the lower category than did the boys.

For Further Research

1. Prior to the enquiry sessions, written questions were submitted by all students of one treatment group. It would appear valuable to assess the effect of enquiry upon the questioning of both participants and non-participants alike. Such a comparison would

entail submission, following the enquiry session, of another set of written questions by all students. Analysis of pre and post enquiry written questions could possibly serve as an indicator of cognitive development arising from enquiry.

2. In the current study, the achievement test was necessarily limited in scope as only so many questions could be asked about subject matter presented in three single concept films. A more reliable testing instrument could be constructed by using more films. Additional information could be obtained regarding the individual levels in Bloom's Taxonomy at which differences in achievement occur.

3. As guidance was found to increase achievement, studies involving the role and degrees of different forms of guidance would be of merit.

4. Using tests involving the higher mental processes, it would be informative to test whether students who normally are non-participants achieve significantly better if they became participants.

5. If participation is a valid predictor of achievement, as it was found in this study, then it would be useful to investigate the factors which lead students to participate.

6. It could possibly be informative to investigate any possible relationship between achievement tests and the depth along Bloom levels which students engage in participation.

7. The enquiry strategy which an individual uses appears to be an unexplored area. Such a study could perhaps be accomplished by Suchman individual enquiry sessions.

8. Classroom enquiry strategy and its possible dependence upon problem type does not appear to have been investigated. This type of study, as also with that in number 6 above, could well aid a teacher in his/her role as a group process director.

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APPENDICES

APPENDIX A

TWO SAMPLE LESSONS WITH SUCHMAN QUESTION CATEGORIZATIONS

The following numbers were used by three people to categorize two lessons along Suchman Categories.

NUMBER	CATEGORY
1	Nominal
2	Normative
3	Condition-description
4	Condition-comparative
5	Structural-component
6	Properties check
7	Diffuse
8	Directed
9	Elimination
10	Substitution
11	Addition
12	Concrete-conceptual

Questions asked by students following film labelled "BOILING".

CATEGORIZATION

1	1	1	Was the liquid water? Ans: Yes
3	3	3	Was the substance put around that bottle cold? Ans: Yes
1	1	1	Was the substance put around the bottle dry ice? Ans: No
3	3	3	Were those plier things that he used made out of steel? Ans: Probably yes
6	6	6	Does heat cause liquid to boil? Ans: Yes
1	2	1	Was the substance put around the flask some kind of ice? Ans: Yes
1	3	3	Was that stuff ice? Ans: Yes
3	3	3	Was the bottle glass? Ans: Yes
12	12	12	Did the liquid have to be water? Ans: No
4	3	3	Was there a temperature change in the water? Ans: Yes
8	8	8	Did the object cause air pressure to build up? Ans: No
8	8	8	Did the water boil again because the air was still hot? Ans: No
3	3	3	Was the water boiling when the cork was put in? Ans: No
4	4	4	Did the water boil after the cloth with the ice was put around did the water boil again? Ans: Yes

CATEGORIZATION

12	12	12	Was it necessary to place the cloth around? Ans: Yes
12	12	12	Was it necessary to put the cork on the bottle before you boiled it again? Ans: Yes
6	6	6	After the water boils and you put a cork on it can the water cool? Ans: Yes
3	3	3	Was the water boiling when it was taken off the bunsen burner? Ans: Yes
8	7	8	Did the ice cause the water to reboil? Ans: It had something to do with it
12	12	12	Was it necessary to put the cork in the container after you took it off the burner? Ans: Yes
8	8	8	Did the ice create a partial vacuum inside the glass? Ans: Yes
12	12	12	Does it matter what kind of cloth the ice was wrapped in? Ans: No
12	12	12	Does it matter what kind of bottle it is? Ans: No
12	12	12	Does it matter if you don't use ice? Ans: No
10	10	10	Could you use any substance at the neck of the bottle as long as it was cold? Ans: Yes
12	12	12	Does the substance you put around the neck of the bottle have to be cold? Ans: Yes
12	12	12	Did the substance he put around the bottle did it have to be put around the neck? Ans: Yes

CATEGORIZATION

12	12	12	Did the liquid have to be water? Ans: No
10	10	10	To make the water boil a second time can you pour cold water around the neck of the bottle? Ans: Yes
12	12	12	Did the liquid in the bottle have to be water? Ans: No
10	10	10	To make it boil a second time could you put it in hot water? Ans: No
10	10	10	To make it boil a second time could you put some dry ice around the neck? Ans: Yes
10	10	10	Would the water have boiled if you put it into hot water the second time? Ans: No
12	7	3	Is vapor pressure involved? Ans: Yes
3	3	3	Was there a partial vacuum inside the bottle? Ans: Yes
12	12	12	Is it necessary to boil the water before you put the ice on it? Ans: Yes
12	12	12	Did the cork have to be placed on the flask? Ans: Yes

THE KNIFE

CATEGORIZATION

1	1	1	Was that water in that glass container? Ans: Yes
3	3	3	Was that knife made of iron? Ans: Partly
8	7	8	Did the heat cause the knife to bend? Ans: Yes it had something to do with it
3	3	3	Was the blade very hot? Ans: Yes
8	3	8	Was the knife dipped in the water to cool off? Ans: Yes
8	7	8	Was it the water that caused the knife to go back to its original shape? Ans: Yes, partly
7	7	8	Did the rubbing of the cloth help to turn it back to its original shape? Ans: No
3	3	3	Was the water at about room temperature? Ans: Yes
8	7	7	Did the cloth have anything to do with the knife bending? Ans: No
3	3	3	Was that burner gas? Ans: Yes
3	3	3	Was the knife dipped into the water when the film first came on? Ans: No
8	4	8	Did the dipping of the knife like from the heat into the water change the molecules back into its original shape? Ans: Yes
1	5	5	Was there a solution in the water? Ans: No

CATEGORIZATION

3	3	3	Was that cloth cotton? Ans: It could have been
7	9	7	Did the rubbing of the cloth have any effect on the knife at all? Ans: No
2	2	2	Was that knife an ordinary knife? Ans: No
8	8	8	Did the water reverse, like when the knife bent from heat did the water reverse the action by being cold? Ans: Yes
8	8	8	Did heat expand the molecules of the knife? Ans: Yes
7	7	7	Did the water have any effect on bending the knife? Ans: Yes
12	8	8	Did which side of the knife, like which side was on the flame, determine whether the knife turned up or down? Ans: Yes
8	8	8	Could the heat make one part of the knife heavier and therefore make it bend? Ans: No
3	3	3	Did the heat of the thing, of the burner stay constant? Ans: Yes
3	3	3	Was the knife unequally heated? Ans: No
12	3	3	Was it heated on different sides? Ans: Yes
5	5	5	Was the knife a compound knife? Ans: Yes
3	3	3	Could the knife have been made of solder? Ans: No
12	4	4	Was the knife held on the fire for the same time each time it was on? Ans: Probably yes

APPENDIX B

ACHIEVEMENT TESTS

THE KNIFE

1. Which of the following statements tells what was done in the film?

   (a) The knife was placed into the liquid and then heated.
L* (b) The knife was heated only once.
   (c) The knife was heated two separate times, and at both times on the same side.
   (d) The knife was heated twice, once on side (1) and once on side (2).

Side (1)  Side (2)

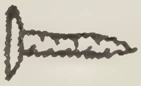
2. For best results so that the knife would bend the handle should be made of:

   (a) wood
H** (b) plastic,
   (c) iron,
   (d) any kind of material.

3. This film showed an example of a PHYSICAL CHANGE. Which of these diagrams also shows a physical change?

L* (a)

a match burning

(b)

a nail rusting

(c)

ice melting

(d)

an egg frying

4. A copper knife was placed in the flame in the same way as the film knife was, but the copper knife did <u>NOT</u> bend. This may indicate that:

   (a) The film knife did not have any copper in it,
L* (b) The flame was not hot enough,
   (c) The copper knife was harder than the film knife,
   (d) None of these.

5. Which statement best explains why the knife bent as shown in Fig. 2?


Fig. 1

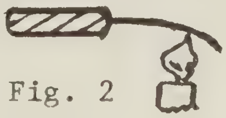


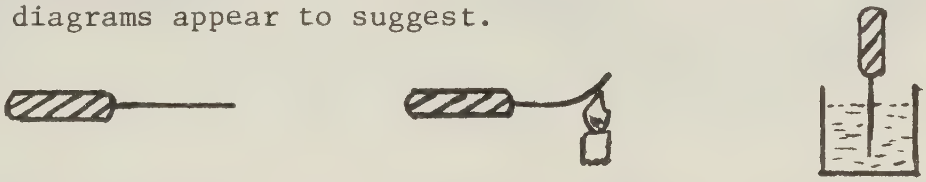
Fig. 2

   (a) Heat softenend the knife and then gravity caused it to bend.
H** (b) The weight of the blade caused it to bend.
   (c) One side of the blade expanded more than the other and so caused it to bend.
   (d) None of these.

6. The knife became straight when placed into the liquid. This was probably due to:

(a) The effect of gravity pulling down the knife blade,
H** (b) One side of the knife blade increasing more in length than the other,
(c) One side of the knife blade decreasing more in length than the other side,
(d) None of these.

7. Look at the diagrams below and then pick one of the four statements which the diagrams appear to suggest.



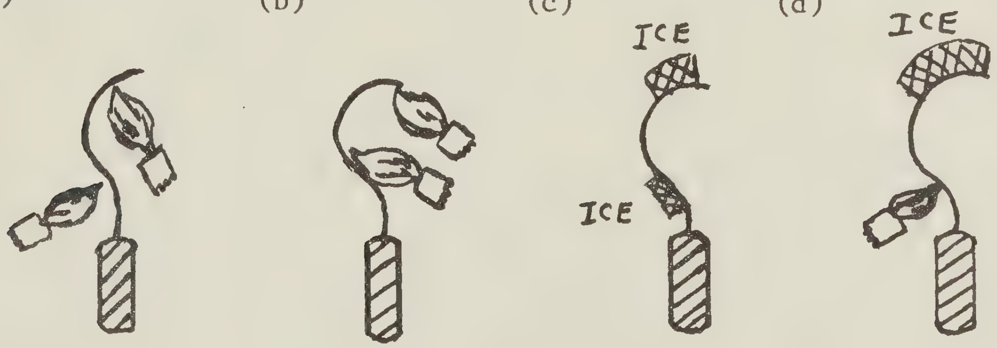
KNIFE IN AIR   KNIFE IN FLAME   KNIFE IN LIQUID

(a) A flame can soften a metal knife and thereby cause it to bend.
H** (b) The temperature of the liquid is much less than that of the air.
(c) The temperature of the liquid and of the air must be nearly the same.
(d) These diagrams do not allow comparisons to be made of temperatures.

8. Which of the following could happen to the knife shown in the film?

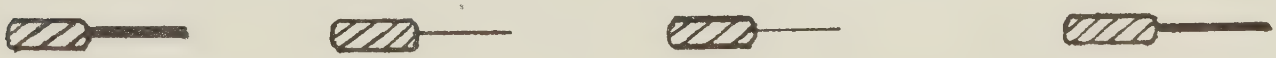
(a)   (b)   (c)   (d)

L*



9. Which diagram shows what the knife blade was probably made of?

(a)   (b)   (c)   (d)



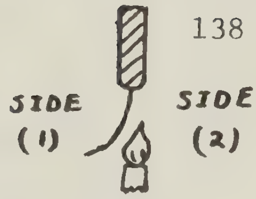
L* (a) Two pieces of the same type of metal welded together.

(b) A "hard" metal.

(c) A "springy" or "elastic" type of metal.

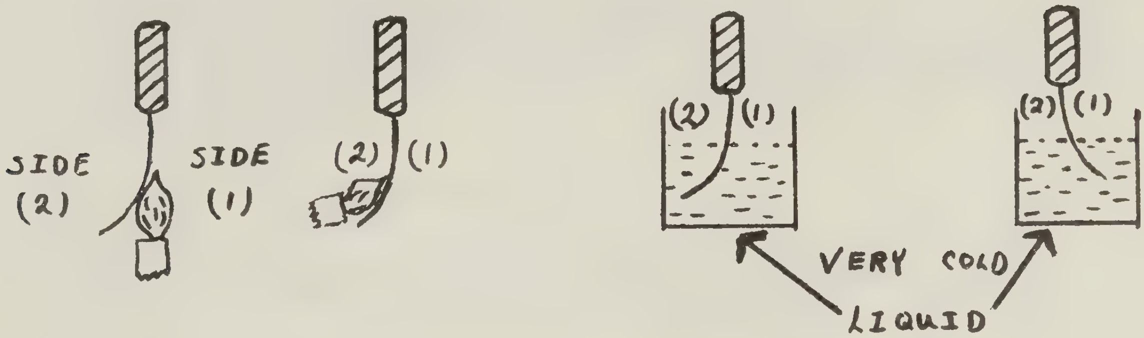
(d) Two pieces of different types of metal welded together.

10. If the knife bends in the way shown in this diagram then which one of the other four diagrams also correctly shows the way in which the knife bends?



(a) (b) (c) (d)

H**



BOILING

1. Choose the best answer to state what was seen in the film.

   (a) The liquid stopped boiling just after the cork was removed from the flask.
L* (b) The liquid started to boil for the second time before the cloth was placed around the neck of the flask.
   (c) After the liquid started to boil for the first time there was a slight wait before the cork was placed into the flask.
   (d) None of these.

2. When was the cork placed into the flask?

   (a) Before the liquid started to boil for the first time.
L* (b) After the cloth was placed around the neck of the flask.
   (c) After the liquid had boiled for the second time.
   (d) None of these.

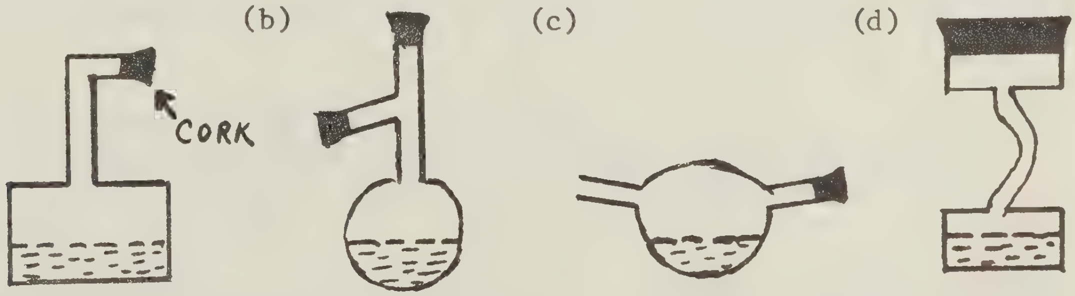
3. In which case would the temperature of the liquid probably be the highest?

   (a) Just before boiling for the first time started.
L* (b) Boiling for the first time.
   (c) Boiling for the second time.
   (d) When boiling for the second time stopped.

4. In which case would you NOT get boiling for the second time as in the film?

H**

(a) (b) (c) (d)



5. Instead of the way shown in the film which of the following methods may also make the liquid boil for a second time?

   (a) Pour boiling water around the neck of the flask.
H** (b) Pour cold water around the neck of the flask.
   (c) Put the bottom of the flask on a block of ice.
   (d) Put the bottom of the flask in a bowl of hot water.

6. What is the most likely reason why the liquid boiled for the second time?

   (a) Putting the cork into the flask did not allow the liquid to cool and so it started to boil again.
H** (b) The objects on the cloth caused air pressure to build up within the flask.
   (c) The objects on the cloth caused a partial vacuum to form in the flask.
   (d) None of these.

7. When the vapor pressure of a liquid becomes greater than the pressure of the gases above the liquid then the liquid starts to:

   (a) cool,
L* (b) boil,
   (c) freeze,
   (d) increase in weight

8. What is a probable reason why the liquid in the flask stopped boiling for a second time?

   (a) All of the air dissolved in the liquid had boiled away.
H** (b) The vapor pressure of the liquid became too high.
   (c) Not enough steam was left in the liquid to cause any bubbling action which occurs with boiling.
   (d) The temperature dropped too much.

9. Choose the best answer to indicate the main thing that this film showed.

   (a) Heat is able to make a liquid boil.
L* (b) Boiling lasts for only as long as the liquid is "hot".
   (c) A liquid can boil even when no heat is applied.
   (d) Liquids can boil.

10. In doing the same experiment, which you saw in the film, a student just brought the liquid in the flask to a boil, removed the bunsen burner and then quickly corked the flask. Which of the following statements best explains why the liquid in the flask did not boil as long or as much for the second time as it did in the film? (The student's experiment was not as successful as it was in the film).
   (a) As the liquid was just brought to a boil before the bunsen burner was removed it would appear that the tmperature of the liquid was not high enough.
H** (b) Not enough of the air in the flask had been replaced by water vapor.
   (c) The flask should have been corked before the liquid started to boil.
   (d) Most of the air in the liquids had already boiled away.

BALLOON

1. Which one of the following was NOT used in the film?

   (a) ballon.
L* (b) can.
   (c) tongs.
   (d) string.

2. Which of the following did NOT happen in the film?

   (a) During the entire film the balloon increased in size only once.
L* (b) The man held the balloon in the tin can with a pair of tongs.
   (c) After the balloon was removed from the tin can the man let some air out of the balloon.
   (d) After being removed from the tin can the balloon had a coating on its surface which disappeared by the end of the film.

3. This tin can most likely contained?

   (a) smoke,
L* (b) a collapsing gas,
   (c) a cold material,
   (d) a hot material.

4. The fact that the size of the balloon increased when being filled with air shows that:

   (a) air has weight,
L* (b) air exerts pressure
   (c) air has a temperature,
   (d) air is colorless

5. Which statement is most likely correct?

   (a) If the temperature is raised the volume becomes smaller.
H** (b) If the temperature is raised the volume becomes larger.
   (c) If the temperature is lowered the volume becomes larger.
   (d) If the temperature is changed the volume remains the same.

VOLUME AND
TEMPERATURE
CHANGES

6. The balloon finally disappeared into the tin can because:

   (a) some air escaped from the balloon,
H** (b) the balloon was forced into the can,
   (c) the pressure in the balloon became greater,
   (d) the pressure in the balloon became less.

7. After the balloon was taken out of the tin can the temperature of the air inside the balloon:

    (a) began to increase,
H** (b) began to decrease,
    (c) remained the same,
    (d) increased at first but then began to decrease.

8. When the balloon was taken out of the tin can it was smaller than before because:

    (a) The air inside weighed less,
H** (b) the air inside the balloon was colder now than before it was put into the can,
    (c) the air inside the balloon was warmer now than before it was put into the can,
    (d) the rubber squeezed harder against the air.

9. The most likely reason why the balloon became larger shortly after being removed from the can was because:

    (a) it had more room to expand,
H** (b) air pressure outside of the can was less than that inside of the can,
    (c) the temperature of the room was higher than in the can,
    (d) None of these.

10. The best explanation for what happened to the balloon from the beginning to the end of the film is that:

    (a) the volume of a balloon can change,
H** (b) air exerts pressure,
    (c) rubber can stretch or shrink,
    (d) pressure changes with temperature.

L* signifies lower category questions in Bloom's Taxonomy.
H** signifies higher category questions in Bloom's Taxonomy.

APPENDIX C

SOCIOGRAM AND ACADEMIOGRAM

NAME____________________, CLASS__________________, SCHOOL________________

The information which you are asked to give to the two questions below may help in understanding how a class learns. Please make your choices carefully. Your answers will <u>NOT</u> be seen by anyone else.

<u>QUESTION 1</u>

Of all the pupils in this classroom, list the names of 5 people whom you would prefer most to have as your friends.

CHOICE 1. ______________________________

2. ______________________________

3. ______________________________

4. ______________________________

5. ______________________________

<u>QUESTION 2</u>

If you were the teacher in this classroom, list the names of 5 people in this room who <u>you</u> feel understand their science best.

CHOICE 1. ______________________________

2. ______________________________

3. ______________________________

4. ______________________________

5. ______________________________

APPENDIX D

LINEAR REGRESSION WEIGHTS

VARIABLES		6	7	8	9	10
	TABLE X	0.837	0.000	0.654	-0.632	0.000
Hyp* 4.0	TABLE XI	0.581	0.000	0.836	-0.101	0.000
	TABLE XII	0.221	0.000	0.000	-0.4367	0.098
	TABLE XIV	0.674	0.000	0.682	-0.692	0.039
Hyp* 4.1	TABLE XV	0.541	0.000	0.822	-0.134	0.000
	TABLE XVI	-0.136	0.000	0.000	-0.203	0.000
	TABLE X	0.000	-1.083	0.000	-1.418	-0.547
Hyp* 4.2	TABLE XI	0.000	-0.685	0.823	-0.167	0.034
	TABLE XII	0.000	-0.342	0.000	-0.508	0.158
	TABLE XIV	0.000	-0.735	0.542	-0.903	0.000
Hyp* 4.3	TABLE XV	-0.069	-0.621	0.805	-0.207	0.000
	TABLE XVI	-0.028	0.000	0.000	-0.548	0.2918
	TABLE XVII	-	-0.203	0.000	0.461	0.000
Hyp* 5.0	TABLE XVIII	-	0.099	0.000	0.943	0.000
	TABLE XIX	-	0.000	0.000	-0.428	0.000
	TABLE XX	-	-0.497	0.000	0.124	0.000
Hyp* 5.1	TABLE XXI	-	-0,353	0.000	0.733	0.000
	TABLE XXII	-	-0.113	0.000	-0.605	0.000
	TABLE XX	-	0.000	0.000	0.000	-0.206
Hyp* 5.2	TABLE XXI	-	-0.040	0.000	0.000	-0.786
	TABLE XXII	-	0.000	-0.103	-0.554	0.000